

MINISTRY OF TRANSPORT

PORPBURY

Reasons for the Minister's decision not
to authorise the construction of a new
dock at Portbury, Bristol

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PORPBURY

In "Transport Policy" (Cmnd. 3057) the Government stated that in their view "the case for allocating a substantial part of the resources available for port investment to the creation of a new major liner terminal, whether at Portbury or elsewhere, has not yet been made out." ("Transport Policy", paragraph 108). This paper sets out in more detail the reasoning, together with the statistical material, on which this conclusion is based.

Introduction

1. In May, 1964, the Port of Bristol Authority, in anticipation of the coming into effect of the provisions of s.9 of the Harbours Act, which did not receive the Royal Assent until June of that year, submitted for the approval of the Minister of Transport Stage I of the Portbury project. It was estimated at that time to cost £27m. for 9 new deep water berths, of which 2 were to be intended for bulk cargoes and 7 for general cargo. Further details of the scheme and a breakdown of its cost are contained in Annex 1. The proposal was examined by the National Ports Council, whose duty under statute it is to tender advice to the Minister on any capital project costing more than £500,000, and in May 1965 the Council recommended that it should be approved. The text of the Council's recommendations to the Minister on this subject will be found in Annex 2.

History

2. The Portbury project was included by the National Ports Council in their Interim Ports Plan (published in July, 1965). Two features distinguished it from the other schemes recommended by the Council in that report. First it involved exceptionally heavy expenditure in relation to the amount of new port capacity to be provided—£27m. for 9 new berths (£3m. per berth) as compared with an average of £1·6m. per berth for the other new development schemes recommended in the Plan. Second, its economic justification postulated a higher rate of increase of cargo tonnage passing through the Port of Bristol than that required in support of the developments proposed at the other principal ports dealt with in the Plan.

3. The high cost is accounted for by the facts that (a) the new dock at Portbury would be built on a virgin site requiring the construction of a large new entrance lock on an estuary of very high tidal range and (b) the project was from the beginning designed on a scale which would allow for an ultimate expansion up to 40 or more new berths. The scheme for which authorisation was sought was thus the first stage of a plan of which the full economic potential could not be realised until the completion of at least the second stage, which would add to the original 9 berths an additional 16 to be served by the same lock.

The appraisal of the scheme

4. In view of these exceptional features of the Portbury project the Government thought it right to order an intensive examination not only of the Portbury proposal itself but of possible alternatives to it in South Wales and Southampton. This examination was carried out on a basis of comparing not the Portbury proposal as originally submitted (i.e. Stage I, covering the new

entrance lock and 9 berths) but Stages I and II, carrying the project forward to a total of 25 berths, with comparable possible developments in South Wales and Southampton. To have compared Stage I of the Portbury project with comparable proposals in South Wales or at Southampton was, it was felt, unduly to weight the scales against Portbury.

5. Before making its submission, the Port of Bristol Authority had commissioned a survey by independent consultants of the potential traffic likely to be attracted to the new port if Portbury were built. Some of the forecasts so provided the Port of Bristol Authority accepted, though on certain important points they considered that their consultants had been unduly cautious. Detailed figures are given in Annex 2 (Annexure B to Part 2). The National Ports Council calculated that the discounted cash flow rates of return on the investment would be as follows—

TABLE 1
Discounted cash flow rates of return

		<i>On the basis of consultants' forecast</i>	<i>On the basis of P.B.A.'s forecast</i>
50 year period	..	per cent Nil	per cent 7.5
80 year period	..	0.9	7.7

Even on the Port of Bristol Authority's more optimistic forecast of traffic the Portbury scheme showed a return that was somewhat less than the minimum normally applied.

6. The outstanding differences between the Port of Bristol Authority's forecast figures and those of the consultants were in respect of petroleum imports and overseas exports. These figures were accordingly examined with particular care. As regards petroleum, the Authority assumed an additional 3.3m. tons of traffic per annum more than their consultants, largely on the basis of the expected development of an oil-fired power station served through Portbury. No decision has been taken on this, but it is possible that such a station will be built there in the next ten years. Having regard to this and other relevant considerations, the conclusion reached by the Ministry was that the Port of Bristol Authority's estimate was reasonable and could be accepted. With regard to overseas exports, the discrepancy between the estimates made by the Authority and their consultants amounted to over two million tons per annum in 1980 (the actual figure of overseas exports for 1963/64 was under 200,000 tons). It was therefore apparent that a detailed and exhaustive examination would have to be made into the likelihood of Bristol's attracting sufficient traffic to justify the construction of a major liner terminal there. The potentiality of Bristol to attract new general cargo traffic exports was in effect crucial to the viability of the Portbury scheme. On this, the consultants employed by the Authority stated "It lies within the control of the port (of Bristol) greatly to increase the flow of manufactured exports through the port, thereby gaining a reasonable share of the current trade of the United Kingdom." The figure submitted by the Authority was based on an estimate, made after consultation with commercial interests, that the port should be able to attract a much larger share of the total United Kingdom export traffic than hitherto. Particular considerations emphasised were that (a) much of

the general expansion of the country's trade was expected to originate in the manufacturing areas of the Midlands and in the London area, (b) the new M.4 and M.5 motorways would provide first class road communications from those areas to Portbury and (c) there was a clear national need for additional outlets and improved port capacity. To put it in another way, the case for Portbury rested in part on its own merits and in part on the need to create a third major liner terminal as an insurance against the ever present risk of congestion and dislocation in the country's two principal ports, London and Liverpool.

Traffic trends

7. For many years decisions in regard to port planning in Great Britain have had to be taken with little or no factual and statistical information concerning the inland destination of foreign imports or the inland origin of overseas exports. In the absence of such information it has been generally assumed that the inland origins of British exports and the inland destinations of overseas imports, whilst concentrated to some degree, have been fairly widely spread over the whole country. At a very late date in the investigation of the Portbury project new material cast an entirely new light on this matter. Basically this information demonstrates that port hinterlands are very much smaller in area than was at first thought. The relevance of this to the consideration of the Portbury project will be apparent from what follows.

8. The information which has enabled conclusions on this matter to be drawn arose from a study done by Martech Consultants, Ltd., who conducted a major survey on behalf of the Port of London Authority in respect of traffic flows in 1964. All Britain's ports were included in the study. All foreign dry cargo trade was covered except imports of iron ore and exports of coal. The survey was conducted on a stratified sampling basis which ensured that all large establishments were covered, the probability of other establishments being covered declining as their size decreased. The response to the survey from these approaches—as high as 90 per cent—shows how seriously those businesses from whom information was sought treated the enquiry. The returns received covered 62 per cent of the total flows to British ports. The information arising from the survey was grouped into 41 geographical areas. The definition of the inland origin of exports for the purpose of the study was the town in which the last stage of manufacture or processing took place. The destination of imports was taken to be the town in which the individual consignment was broken up, commonly termed the point of breaking bulk. In respect of some imports, though not the majority, the point of breaking bulk is not the same as the ultimate destination. Imports of foodstuffs, for example, eventually find their way all over the country, with a spread corresponding fairly evenly to that of the population, though in some cases not before some further processing at the point of breaking bulk. The majority of basic materials, on the other hand, largely because of the high cost of their transport, tend to be consumed or processed in close proximity to port areas. The conclusions drawn from the survey in respect of imports should be studied with this definition (and limitation) in mind, but the central point in relation to the Portbury problem, so far as traffic availability is concerned, related to exports rather than general cargo imports.

9. The statistical information arising from the survey was made available to the Ministry of Transport, at their request, by the Port of London Authority, and has been analysed by the Ministry's Economic Planning Group. A summary of the export figures is contained in Annex 3. The Ministry's analysis took basically two forms—a radial analysis and the construction of a gravity model. The radial analysis described circles of varying mileage around each of 25 major British ports, established the tonnage of exports originating and the imports terminating within those circles, and measured the extent to which, as distance increased, the pull of other British ports increased. The results, for all the 25 ports taken together, are set out in the following table:—

TABLE 2

Percentage of Exports coming from and Imports* going to places at specified distances from major ports†, 1964

Distance from ports	Exports (by weight)		Imports (by weight)	
	per cent of total	cumulative per cent of total	per cent of total	cumulative per cent of total
0–25 miles	..	39·9	39·9	63·6
25–50 miles	..	17·2	57·1	10·8
50–75 miles	..	8·4	65·5	11·1
75–100 miles	..	11·2	76·7	6·5
100–125 miles	..	7·3	84·0	3·3
125–150 miles	..	3·7	87·7	1·7
150–175 miles	..	2·7	90·4	1·0
175–200 miles	..	4·1	94·5	1·4
200–225 miles	..	1·6	96·1	0·2
225–250 miles	..	2·8	98·9	0·2
Over 250 miles	..	1·1	100·0	0·2

* Distance refers to the point of breaking bulk in respect of imports.

† The figures in this table are the total of the following ports : London, Liverpool, Hull, Glasgow, Southampton, Manchester, Grangemouth, Tees, Cardiff, Bristol, Newport, Swansea, Immingham, Goole, Grimsby, Dover, Harwich, Felixstowe, Newcastle, Sunderland, Ipswich, Leith, Yarmouth, King's Lynn, Shoreham.

10. This analysis shows how important nearness to a port is in determining to which port traffic goes. From the table it can be seen that 2/5ths of all Britain's sea-going exports travel less than 25 miles to their loading port and 2/3rds travel less than 75 miles. For imports the position is even more marked ; almost 2/3rds of all imports travel less than 25 miles from port of unloading to destination, and some 4/5ths less than 75 miles. The conclusion to be drawn from the analysis so far is that Britain's ports have concentrated and fairly clearly defined hinterlands.

11. The distances travelled by exports and imports to and from Britain's two existing major liner terminals, London and Liverpool, can be seen from the following table:—

TABLE 3

Distances Travelled by Exports and Imports to and from the Ports of London and Liverpool

	0–25 miles	0–50 miles	0–75 miles	0–100 miles	0–125 miles	0–150 miles
<i>Exports</i>		<i>Percentage of total Exports</i>				
London	33	62	68	71
Liverpool	43	51	58	74
<i>Imports</i>		<i>Percentage of total Imports</i>				
London	71	79	93	93
Liverpool	80	87	88	95

London and Liverpool each have large conurbations, which generate large tonnages of both imports and exports. The bulk of their trade comes from those conurbations, and practically all the trade *in* those conurbations goes to its local port.

12. The radial analysis also demonstrated that 94 per cent of the imports terminating within a radius of 25 miles of central London and 79 per cent of exports originating in the same area used the local port. For Liverpool the figures are 83 per cent and 81 per cent respectively. As the distance increases, so the proportion of traffic within the ring going to the nearest port decreases. This is shown in the following table:—

TABLE 4

Traffic arising and terminating in 25 mile rings round London and Liverpool and passing through these ports expressed as percentages of total traffic arising and terminating in these rings

Ring	London		Liverpool	
	Exports per cent	Imports per cent	Exports per cent	Imports per cent
0– 25 miles	79	94	81
25– 50 miles	79	48	53
50– 75 miles	49	57	37
75–100 miles	43	14	31
100–125 miles	29	7	22
125–150 miles	26	27	11
150–175 miles	13	3	13
175–200 miles	7	2	6

13. The bulk of the manufacturers to whom importing or exporting overseas is an important part of their trade tend to be grouped in fairly close proximity to the major ports. The absence of any earlier study of this kind prevents any conclusions being drawn as to whether this tendency is becoming more or less pronounced, but that it exists at the present time is not in doubt. As distance is probably the most important factor in road and rail freight rates for any given consignment (although of course not the only factor), future port planning must take this concentration into account in deciding on new port investment.

14. Exports tend to travel rather further than imports. The average distance travelled for exports in 1964 was about 66 miles; for imports it was 36 miles. But generally, whether for imports or exports, distance from a port is a major factor in determining which port is used. Transport costs represent a higher proportion of the value of imports than they do for exports; of the exports and imports studied in this survey, exports have a value in the region of twice that of imports. There are some ports with less clearly defined hinterlands, such as Dover and Felixstowe, which offer specialist short-sea services to and from the continent for which they are on the direct route. The highest value commodities tend to be less concerned with distance to ports and are attracted longer distances. Such tonnages are in absolute terms very small, and are not of the order of magnitude relevant to the consideration of a major liner terminal.

15. The second form which the analysis of the data provided by the Martech survey took was the construction of a "gravity model". These models are an established method in transport planning of determining transport flows in terms of the relative attraction of certain locations and

the relative distances between them. The model has two parameters and a range of values of these two parameters was tested on a computer until a pair of values were obtained giving relationships between the variables which best described the pattern of export and import flows separately to and from Britain's ports. One of the parameters expressed the implied attraction of each port in relation to the size of the port and the other the extent to which this attraction declined with distance. The final values of the parameters reflected the fact that exports tend to travel further than imports and that the size of the port is a more important factor in determining export flows than it is in determining import flows. A mathematical analysis of the flows to and from ports will be found in Annex 4.

16. The degree of fit between the tonnages indicated in the gravity model and the actual 1964 tonnages was very good. It may be of interest to note that for the Port of Bristol the actual exports in 1964 were 196,000 tons, whereas the model suggested 142,000 tons. For imports, Bristol's actual tonnage in 1964 was 3·183m. tons against a calculation by the model of 3·183m. tons.

17. The gravity model was used not only to describe the existing situation but also as a model forecasting future potential flows, based on existing trends. The national trade increases forecast by 1975 which were used by the National Ports Council in their Interim Plan were projected forward a further 5 years to 1980 at the same rate of growth. This gave an increase of exports by 1980 of 84 per cent over 1964 and of imports of 56 per cent. These were applied uniformly to the flows of each standard region and the potential flows of imports and exports derived for each port. This method of forecasting traffic for ports in effect allocates future traffic according to the existing gravity model relationships.

18. The forecasts which emerged in respect of the Port of Bristol were some 4·95m. tons of dry cargo imports but only 0·26m. tons for dry cargo exports. Hence, whereas the Port of Bristol Authority's estimates of import tonnages in relation to Portbury appeared reasonable in the light of the gravity model forecasts, their export forecast of 2·7m. tons was very different from the gravity model forecast of 0·26m. tons, and from their consultants' forecast of 0·47m. tons.

Possible Exports for Portbury

19. In view of the fact that to approach a viable position the attainment of the full Port of Bristol Authority export forecast was necessary, an examination was made of ways in which the export forecast of 2·7m. tons might conceivably be attained. This involved consideration of the possibilities of diverting the required additional 2·4m. tons of export cargo from other ports as well as the implications of possible population migration into the Bristol area.

20. For this purpose, the radial analysis proved useful. It was at once apparent that there was relatively little export traffic within a 75 mile radius of Bristol which had not already been forecast as using that port. Hence any additional export traffic would have to come either from the 75–100 mile ring (which includes most of the Birmingham conurbation) or

the 100–125 mile ring (which includes most of the London conurbation). (Bristol at the present time draws a large part of its exports from the 75–125 mile ring, but with a total export tonnage of 196,000 tons this can hardly be significant.) The major export tonnages within these various rings, together with their forecast increase, can be seen below:—

TABLE 5
Major exports arising within 75–125 miles of Bristol

		1964	Forecast Growth 1964–1980
000 tons			
<i>75–100 mile ring</i>			
South Western	..	200*	190*
Wales	..	1,300	1,100
Midland	..	1,500	1,280
Southern	..	500	420
<i>100–125 mile ring</i>			
London	..	2,000	1,700

* China clay is excluded from these export figures because almost all the clay exports flow from its concentrated production area through certain specialised ports of which Teignmouth, Par, Fowey, Poole, Plymouth, Penzance and Bideford are the most important. The high transport cost in relation to its value precludes it for consideration as a potential export traffic through Portbury.

21. A large part of the South Western region's export traffic (other than china clay) is already handled by Bristol, and Welsh goods are handled in the main by Welsh ports. The Midland region is at present catered for mainly by London and Liverpool, and the Southern region by London and Southampton. The London conurbation is served by the Port of London almost exclusively. The nearest large concentration of export manufacture from which Portbury might draw traffic would seem to be the Midlands.

The Likely Direction of Britain's Trade Growth

22. An assessment of the export flows likely to come to Portbury requires consideration of the probable future growth of export trade by world zone. This is because in general East Coast ports tend to serve Europe (though not only Europe) and West Coast ports North America and other deep-sea routes. For instance, only 10 per cent of the exports of West Coast ports go to the European Economic Community (excluding Italy) and to Austria and Switzerland,† whereas some 30 per cent of all exports from East Coast ports, and 33 per cent of all South Coast ports' exports are destined for that zone. Just under 9 per cent of Bristol's exports are bound for that zone. Freight rates from West Coast ports to near continental ports are generally higher than those from South or East Coast ports.

23. It was clear from this that a study of the likely growth of trade according to world zone was essential to any appraisal of Portbury, which

† This somewhat peculiar European grouping arises from the classification in the study done for the Port of London Authority referred to in paragraph 8. That study was concerned with the European ports used rather than the ultimate destination. Hence, Switzerland and Austria were included within a group loosely referred to as "European Economic Community". Also since it was thought that the bulk of traffic between Italy and Great Britain went by sea directly between ports of these two countries Italian trade was not included in this "E.E.C." grouping which was intended to include only short-sea traffic.

apart from being located on the West Coast was a deep water berth development designed primarily for the deep-sea trades. A study was therefore made of trends in the direction of trade over the last 15 years and over the last 10 years, dividing the world into 9 zones. Rates of change in the shares of each zone over these two periods were calculated and projected forward 15 years beyond 1965. The results are given in Annex 5. The most notable features are the increase in the European trades and the decline in relative importance of the deep-sea trades. The three short-sea zones of the European Economic Community (excluding Italy), European Free Trade Area (excluding Portugal) and Eastern Europe (excluding Rumania) were expected to account for between 56 per cent and 64 per cent of the growth in export tonnage and between 37 per cent and 43 per cent of the growth in import tonnage, the higher figure in each case being the result of 10 years' past experience and the lower being the result of 15 years' past experience. If the United Kingdom joined the European Economic Community the proportion of trade growth on Community routes could be expected to increase significantly. The Portbury development would be unsuitable for catering for this growth since extra shipping costs on the longer voyage would be incurred by traders.

24. As Portbury is designed for deep-sea trade, it could in theory absorb the increase of medium-sea and deep-sea exports forecast for the Midland region, i.e. excluding those exports which go to ports on the North Coast of continental Europe or Scandinavia; based on the forecast for the whole country, this would represent some 36-43 per cent of the expected growth in Midlands exports (see table 5 above). This percentage includes medium distance as well as deep-sea trade. Hence, if Bristol gained *the whole of this increase* to the exclusion of other ports, the additional tonnage available to Bristol would be of the order of 500,000 tons.

25. Bristol might also be able to attract some of the Midlands' deep-sea exports which at present go through Liverpool or London. Some two-thirds (about one million tons) of the current Midland region's exports are estimated to be deep-sea or medium-sea cargoes. If Bristol were able to attract a third of this traffic from Liverpool and London this would give Portbury an extra 330,000 tons.

26. To sum up, if Bristol attracted the whole of the increase in deep-sea and medium-sea exports of the Midland region (say 500,000 tons) and was successful in attracting one-third of that region's existing exports of that type (say 330,000 tons), and if these tonnages were entirely additional to the gravity model's estimate of 260,000 tons for Bristol in 1980, which strictly speaking they are not, it will be evident that a further 1.5m. tons of exports would still be required to be diverted from the ports to which they would otherwise flow in order to reach the Port of Bristol Authority's figure of 2.7m. tons.

27. Such diversion, even if it could be achieved, would involve additional haulage costs. The Portbury site is well situated for access from the motorway network. It is about 8 miles south of the junction between the London—South Wales and the Birmingham—Bristol motorways, M.4 and M.5, and the site is immediately adjacent to the line of the M.5. This excellent position

and easy means of access to the main road system of the country is an important advantage, but it is not decisive. Road improvements are taking place on a considerable scale which will facilitate access to our major ports ; others are being planned and will include the provision of motorways where there is a need. Moreover, it would still remain the case that exports diverted to Portbury from other areas would have to travel longer distances, and while other factors are clearly taken into account in fixing haulage rates, distance must always be a major consideration. While goods originating near the M.4 and M.5 would enjoy free traffic movement, the distance from the point of origin of the goods to access to the motorway network is bound to be taken into account. It is estimated, conservatively, that the additional haulage charges for the 1.5m. tons of diverted exports referred to in paragraph 26 would amount to approximately £1m. a year ; on average, about 14s. Od. extra on each ton of exports. This additional cost would be a handicap to the prospects of Portbury's attracting this traffic unless countervailing savings could be achieved. But the high capital costs of the Portbury scheme would militate against such a possibility in relation to the fixed costs at the port.

28. The other way in which the balance of 1.5m. tons of exports referred to in paragraph 26 might be achieved would be by the exercise of Government policy in regard to population distribution and location of industry. Such a policy could in theory be so designed as to build up the population of Bristol and its hinterland to a size which would generate the necessary exports. On average, a population of one million people tends to generate between 300,000 and 500,000 tons of exports per year. To achieve the balance in this way would therefore require an increase of the order of 3 millions of population in Bristol and its hinterland.

29. It could be argued that the deficiency of 1.5m. tons does not need to be exports, but could be imports. A population of one million people in a large conurbation tends to generate in the neighbourhood of 1.1 million tons per annum of exports and imports combined. Hence a population migration of 1.25-1.5 million people in close proximity to Bristol would still be necessary by 1980 (the population of the Bristol area in 1964 was 857,000). It will be appreciated that the gravity model forecasts already take account of the expected national average natural increase of population in the area. The evidence of the South Hampshire Study concerning possible rates of population migration, and other similar studies, shows that the build-up of population through migration of even an additional 1.25 million people must take very many years ; it is entirely unlikely that a build-up of this magnitude could be achieved by 1980. Although efficient port facilities must be available and geared to location of industry and population development, they can hardly be regarded as an effective weapon for bringing such developments about.

The "Container Revolution" and its implications for a new major liner terminal

30. The conversion of trade forecasts for ports into the number of berths required to cater for the trade is a difficult task at any time. It is even more difficult when techniques are changing, and this is almost certain to be true for the years which lie immediately ahead. Ports can no longer be regarded as having a fixed throughput comparable with what is being achieved at

general cargo berths to-day. The advent of what has come to be known as the "container revolution" has major implications for British ports: whereas a modern berth to-day has a throughput of the order of 80,000-120,000 tons per annum, container berths can be expected to have a throughput of 1 million tons per annum or more. The impact of containerisation on Britain's port industry is one of the most important factors relevant to the planning of Britain's future port capacity.

31. Container shipping operations have made dramatic progress in the United States in recent years. Over 4/5ths of the U.S. inter-coastal general cargo trade is now containerised. The rate at which such changes can take place, given favourable economic conditions, can be seen by the fact that between 1957 and 1959 there was a four-fold expansion in the New York coastal container traffic, from 228,000 tons to 1,069,000 tons per annum. Over 2/3rds of the general cargo trade from the U.S.A. to Hawaii and Alaska is also containerised. On the other routes to and from the U.S. this method is still in its infancy, but only this year one major American shipping company started a regular container service to Rotterdam; others are planning similar developments; certain Scandinavian shipping companies are about to offer container services across the North Atlantic. British shipping companies are also to the fore in planning container services. Last year leading British shipping companies formed themselves into two container consortia. The agreement of H.M. Customs and Excise to facilitate the establishment of inland clearance depots has opened up the prospect of a substantial growth of container services on the sea routes to this country.

32. Substantial economies from container operations are likely to occur at Britain's ports which will benefit both the shipowner and the shipper. Ships at present transporting break-bulk cargo tend to spend over half their working life in port. The time container ships spend in United States ports is said to be only one-fifth of that of conventional ships, hence ship utilisation is higher. Stevedoring costs are said to be roughly one-fifth of those for non-container cargo. Other savings such as packaging, insurance, quicker service etc. can also be expected to result. Against this must be set the capital cost of containers, the expensive handling gear, and the high capital cost of the ship itself, and at the present time no one can be completely certain that containers, as opposed to other methods of unitisation such as the use of pallets, will win the day over the greater part of the general cargo field. But containerisation is bound to come over a large part of port operations.

33. The present debate in this country is not concerned so much with whether containerisation will come at all—it is with us now—as with the rate at which it will take place, the extent of its ultimate role, and its consequences on port planning. One firm of American management consultants have recently expressed the view in a study on containerisation that 70 per cent of all North Atlantic general cargo trade will be containerised by 1970 and that 50-60 per cent of the free world general cargo will be containerised by 1975; the percentage may rise to more than 80 per cent by 1985.

34. The implications of the container revolution for the whole future of Britain's trade and industry, its shipping and ship-building policy and the future course of port investment are far-reaching and will require most intensive study. Its relevance to the proposed development of Portbury is not

that, of itself, it constitutes a decisive factor against such a development ; indeed, it can be argued by supporters of Portbury that the very large area of land available behind the port would make it an excellent place for a container terminal. It does, however, weigh heavily against Portbury for two reasons ; in the first place, it casts considerable doubt on the desirability of investing a very large sum of money in a very large number of berths, especially in the light of the arguments developed above about the extreme unlikelihood of Portbury attracting sufficient cargo, particularly export cargo, to make it viable. Even more important, perhaps, is that it almost destroys the argument in favour of Portbury as a third major liner terminal needed as an insurance against the risk of congestion and dislocation in London and Liverpool. If a single container berth can handle one million tons and more of cargo per annum, the need is to concentrate development, either by the modernisation of existing berths or the construction of new ones, at existing ports serving large conurbations rather than by the construction of entirely new facilities elsewhere. It is for this reason that the Government have asked the National Ports Council to review the proposals put forward in their Interim Plan and to prepare a phased programme of selective investment in port facilities which, while earning an economic return in the short-term, can form the nucleus of further port expansion where this is required by large scale industrial and housing development programmes. In this study the future development of containerisation is bound to play a dominant part.

The Position of the National Ports Council

35. The recommendation of the National Ports Council in favour of the Portbury project, reproduced at Parts 1 and 2 of Annex 2, was made before the material and analyses described in paragraphs 7 to 21 above had become available. They have been closely associated with the further examination which took place earlier this year and have had full access to all the information available on the subject. Their considered views are set out in Part 3 of Annex 2. They remained satisfied that there was a case for a new major liner terminal at Portbury on long-term port planning grounds ; and that the benefits which would accrue to the nation from the development of a new port on this location were so great as to justify the large capital expenditure involved and the considerable efforts that would be needed to launch it. They recognised that it must be a major act of faith to commit financial resources to Portbury but were certain that such a decision should be made. In short they considered that the undertaking was worth the risk.

Conclusion

36. Paragraph 4 above explains why the Government thought it right to order an intensive examination not only of Portbury itself but of possible alternative sites in South Wales and Southampton. It may be as well at this point to state that the result of this examination was to demonstrate that no one of the sites investigated had outstanding advantages over the others. For all of them ample land was available or could be made available ; some of the sites were better served by road communications than others, but for the reasons given in paragraph 27 above this was not held to be a decisive factor. The conclusions to be derived from the analyses of the Martech data and the impact of the container revolution applied to the alternative sites examined as weightily as they did to Portbury.

37. The conclusion announced by the Government in "Transport Policy" that the case for the creation of a new liner terminal, whether at Portbury or elsewhere, had not yet been made out rests essentially on two considerations. The first of these is the argument, set out in paragraphs 7-29 above, that there is no foreseeable prospect of a new major liner terminal, whether sited at Portbury or elsewhere, attracting anything like enough traffic, import or export, in present circumstances to justify the very large capital expenditure involved. It has been shown (paragraphs 28 and 29) that population movements on the scale required to give Portbury or any other site the likelihood of proving itself a viable project are unlikely to take place except over a very long period. As stated in "Transport Policy", "the planning of large-scale port facilities, therefore, must be closely related to plans for the redistribution of industry and population. The Government is setting on foot studies of the development of Humberside, Severnside and Tayside. These and other studies will provide information from which will flow major decisions on the redistribution of population and regional development. Even when decisions are taken, the necessary large-scale build-up of housing and industry will inevitably be spread over a number of years. It would be many years, therefore, before the capital committed to a new major terminal, at Portbury or elsewhere, could begin to earn an economic return." ("Transport Policy", paragraph 106.)

38. The conclusions derived from the analyses of traffic flows which the Martech data made possible are reinforced by the second consideration which influenced the Government in their conclusion, viz. the implications of the container revolution. While, as has been stated above, we are a very long way as yet from being in a position fully to evaluate the effects of this revolution, it is already possible to say with some confidence that it clearly points to the desirability of concentrating the future development of modern port facilities, whether by way of the construction of new berths or the modernisation of existing berths, at selected existing growth points in preference to the construction of very large numbers of new berths on virgin sites.

39. The examination of the Portbury project and other possible sites for a new liner terminal has clearly demonstrated the overriding need to plan port developments as an integral part of the overall planning for the redistribution of industry and population, to relate them to the potential growth in demand for port services which is thereby generated, and to give full value to the immense implications of the container revolution. As has been indicated in this paper, there are other aspects in which the Portbury study has led to a reassessment of the various factors which should determine the nature and extent of port investment. The criteria which need to be applied in evaluating new major port facilities are now much more clearly known than ever before and are already proving to be of very great importance to the Government and the other agencies concerned in the planning of port developments.

ANNEX 1

DETAILS OF THE PORTBURY PROPOSAL

The scheme submitted to the Minister for approval consisted of an entrance lock 1,200 feet in length, 140 feet wide and with a depth of just over 47 feet, together with 9 berths in the first stage. Two of these were to be bulk cargo berths and seven were to be general cargo berths. Road and rail facilities on the quays and at the rear of the sheds were to be provided. The two bulk import berths each 800 feet in length were to be designed to cater for a 43 foot draught ship.

The seven general cargo berths were to be 650 feet long but the layout allowed for some flexibility in length of the ships using the berths at any one time. These general cargo berths were to be equipped with travelling portal electric cranes with capacities of at least 6 tons. The quays were designed to carry heavy mobile cranes and other mechanical equipment.

The transit sheds were planned as very long units, each covering two berths, catering for varying ship lengths, and were to be some 150 feet wide with a clear roof span to enable the greatest use to be made of mechanical equipment.

The layout allowed for the need for the marshalling and control of rail and road vehicles and internal communications were planned with the main access arteries leading down the centre of each main tongue of berths. There was provision for road vehicles to park without interfering with the flow of road traffic to and from the berths.

The Portbury site comprises some 2,000 acres of land, of which it was proposed to develop about 1,000 acres in the initial phase, leaving the remaining area to be taken up in later years as the need arose for additional deep water berths.

The planned utilisation of the 9 berths constituting Stage I was one berth for petroleum imports, one berth for the import of zinc ores and concentrates, three berths for containers (of which two were for exports) and four berths for general cargo (of which three were expected to be for exports).

The Port of Bristol Authority submitted preliminary estimates of the cost of the engineering work at Portbury, but it was stressed that as no detailed drawings had been prepared for any of the structures, it was impossible to produce close estimates at the time of the submission. The estimates were therefore rough-guide figures only, based on approximate quantities of civil engineering work and based on the average prices ruling in 1963.

Portbury Estimate Stage I

							£
Land ..	..	..	..	..	..	..	1,000,000
Earthworks ..	..	..	..	..	..	..	3,500,000
Dredging ..	..	..	..	..	..	..	1,000,000
Sea wall ..	..	..	..	..	..	..	3,000,000
Entrance lock and pumphouse ..	..	..	..	..	..	..	6,500,000
Lead-in jetty ..	..	..	..	..	..	..	400,000
Dock and basin walls ..	..	..	..	..	..	..	5,750,000
Transit shed ..	..	..	..	..	..	..	500,000
Railways ..	..	..	..	..	..	..	500,000
Roads ..	..	..	..	..	..	..	650,000

Portbury Estimate Stage I—continued

	£
Drainage and other services .. .	100,000
Dock offices and other buildings .. .	150,000
Cranes and mechanical equipment .. .	550,000
Diversion of electrical power .. .	900,000
Electrical power and lighting .. .	500,000
	<hr/>
	25,000,000
Design and contingencies .. .	2,000,000
	<hr/>
	£27,000,000
	<hr/>

ANNEX 2

THE NATIONAL PORTS COUNCIL'S RECOMMENDATIONS

PART 1

Letter dated 28th May, 1965

I am now in a position to let you have the Council's considered recommendation on the Port of Bristol Authority's scheme for a major new dock at Portbury. The scheme is described in a bound report produced by the P.B.A. of which I believe you have received copies. The essential feature of the scheme is that it will provide, in its first stage, 9 new berths, with depth of water up to 45 ft. at bulk berths, at an estimated cost of £27 million.

2. This report was submitted to the Council in May last year. As you will yourselves have no doubt realised, it was presented in a form conventionally used for local authority accounting purposes, and on studying it we quickly came to the conclusion that it would be essential to require the P.B.A. to produce more extensive statements of traffic and financial forecasts on commercial lines, such that we could make a proper appraisal of the scheme's prospects. This work has taken a considerable time and has involved a great deal of correspondence and interchange of visits between ourselves and the P.B.A., and also with other bodies and organisations. In March this year the full Council visited Bristol for the purpose of inspecting the site for the proposed new dock and obtaining at first hand views of interested bodies.

Economic Aspects

3. Following the Council's request for additional information the P.B.A. initially invited a firm of consultants to project further some traffic forecasts for the Port of Bristol (a) with Portbury and (b) without Portbury which they had supplied to the Authority at an earlier stage. Dissatisfied with the results of the consultants' projections they then decided to produce their own traffic forecasts. Both sets of traffic forecasts, for the year 1980, are set out in Annexure A.

4. It will be noted that there is a marked difference in the two sets of forecasts. Essentially it seems to the Council that the difference turns on the likelihood of Portbury's becoming a terminal port. On this issue we have consulted with both the Chamber of Shipping and the British Shippers' Council as well as the bodies which gave evidence to the Council on the visit to Bristol which has been mentioned earlier. There seems to be no doubt that shippers generally would welcome a major port development on this scale away from the ports of London and Liverpool. The shipowners' reaction was that, given the Portbury scheme, reasonable expectations could be entertained of growth of the Port of Bristol and of its becoming a terminal port. Clearly we are on uncertain ground here and it is fair to say that on a cold appraisal it could be held that the build-up of traffic at Portbury will be considerably slower than the P.B.A. hope.

5. On the other hand, it is necessary to bear in mind the attraction of very modern deep water facilities. Once the project was completed and operations begun on a full scale it could be that the pressure of demand for these facilities would build up very rapidly. It is important to register here the Council's firm view that the situation we have been considering would generally obtain in the case of a development providing a comparable extension of facilities outside the ports of London and Liverpool. It seems best, therefore, to regard the two sets of forecasts as indicating the lower and upper limits of probability, the one forecast pessimistic and the other optimistic. Major port investment is a field in which a certain degree of optimism is not only justifiable but necessary, for without willingness to accept a substantial degree of risk the chances are that no development on a scale comparable to that proposed at Portbury will be undertaken outside the two dominant major ports already referred to. The Council have concluded that it is right to think in terms of prospects for Portbury perhaps falling somewhat short of Bristol's hopes but representing a substantial improvement on the consultants' forecast.

6. While I have dealt in the preceding paragraphs with the question of the general validity of the two sets of traffic forecasts, it is necessary to comment on one particular commodity, i.e. petroleum. To a substantial extent the P.B.A.'s traffic forecasts for this commodity stem from their expectation that an oil-fired power station and an oil refinery will be constructed in the Portbury area. It seems highly probable that there will be a power station, and although no final decision has, so far as we know, yet been taken that it will be oil-fired, we understand that the C.E.G.B. are thinking on these lines. The prospects for an oil refinery may be somewhat speculative at this point in time, but traffic for such a refinery is included in the consultants' as well as the P.B.A. forecasts.

7. Before proceeding to a discussion of the revenue forecasts it should be explained that the P.B.A.'s traffic forecasts are based on the following planned utilisation of the 9 berths:—

- 1 berth —Petroleum (imports)
- 1 berth —Other bulk cargo (zinc ores and concentrates—imports)
- 3 berths—Containers (2 export, 1 import)
- 4 berths—General cargo (roughly divided as between 3 export, 1 import)

Despite this indication of the likely distribution of the berths as between export and import cargoes, it should be borne in mind that the advantages of container operations are such that it should be perfectly practicable to arrange for all container berths to deal with traffic flowing both ways.

8. The rates which the P.B.A. propose to charge on the various main traffics are set out in Annexure B. I feel bound to observe that a further measure of optimism appears to enter here. While such rates might well be obtained given a wide range of established shipping services and trade supporting them, and while we agree with the P.B.A. that these are the kind of rates which ought to be secured, it must be recognised that the P.B.A.'s bargaining power in the early stages of the build-up of traffic will be weak and it is by no means certain that such rates could be obtained initially.

Financial Aspects

9. The P.B.A. produced for us revenue forecasts based on their own traffic forecasts, but it was only recently that they provided information on which we ourselves have been able to assemble revenue forecasts based on the consultants' traffic forecasts. The revenue forecasts derived from both sets of traffic forecasts are set out in Annexure C, again for the year 1980. The statement shows the forecast net receipts for that year. The consultants' traffic forecasts were presented in terms which separated Portbury from the rest of the Port of Bristol, but we have had a good deal of correspondence with the P.B.A. before securing their agreement to making similar separate traffic and revenue forecasts themselves. We ought at the same time to say that the P.B.A. consider that the facilities of their port must be looked at as a whole and that the separation of results for Portbury from the rest of the Port of Bristol is unjustifiable.

10. We have used both sets of forecasts to make discounted cash flow analyses. The results of these exercises, giving the indicated rate of return before tax on varying traffic forecasts and for two selected periods, are set out in the table below.

<i>Traffic forecast basis</i>	50-year period		80-year period	
	per cent	per cent	per cent	per cent
Consultants	Nil	0·9	
P.B.A.	7·5	7·7	

The d.c.f. calculations have been discussed with the P.B.A. who have agreed the underlying assumptions but at the same time have registered a strongly held view that this method of assessment is inappropriate to major port projects of this nature.

11. Because of this view of the P.B.A. on the merits of d.c.f. analysis—and we are aware that they are not by any means alone in holding this view—and because in the event of an adverse decision on the Portbury scheme this issue seems certain to be raised, we have felt it only right to make in addition a conventional accounting appraisal of the scheme. We accordingly set out at Annexure D a graphical presentation of the net results on a conventional basis, i.e. after interest at 6½ per cent but before tax, calculated from both consultants' and P.B.A. traffic forecasts. The results are plotted cumulatively, so that the point of intersection of the net results for Portbury with the horizontal axis shows that on P.B.A. forecasts a cumulative break-even point is reached in 1991, after which year surpluses become available. The divergence of the consultants' graph line from the horizontal axis shows that their forecast results for Portbury will never achieve a break-even point, and cumulative deficits increase rapidly.

Technical Aspects

12. A number of consultations on the technical aspects have taken place with the Engineer-in-Chief and the Havenmaster of the Port of Bristol Authority and the consulting engineers to the Authority, who prepared the

preliminary plans and estimates. The hydraulic model at the Hydraulics Research Station, Wallingford, has also been inspected. The Council are satisfied that:—

- (a) The scheme is feasible from a technical point of view.
- (b) The estimates, which are based on approximate quantities at reasonable rates, are as accurate as it is possible to achieve at this stage.
- (c) The type and layout of the facilities are suitable for a modern port development.

13. In a scheme of this magnitude, considerable consultation and attention to detail is required in the design stage to determine the exact nature of the facilities to be provided and this may result in some modification to the original plan. In this case the Port of Bristol Authority have in hand a careful appraisal of the economics, from an operating point of view, of the length of lock to be provided, and tests are in progress at Wallingford to determine the best alignment of the lock and entrance jetty and the extent of dredging in the approach manoeuvring area to achieve the optimum conditions for handling vessels. It may also be possible to develop the scheme more closely in line with the growth of traffic and to design special terminals for the oil and bulk handling facilities in preference to the construction of a dock with continuous quays throughout. Attention to these points may result in some saving in the total cost quoted in the provisional estimate.

Review of advantages and disadvantages of this scheme

14. It is in the light of the preceding economic, financial and technical appraisal that the Council have considered the advantages and disadvantages of the scheme. The disadvantages, as we see them, are:—

- (i) The scheme is admittedly expensive in terms of cost per berth. However the average cost per berth will be substantially reduced given the construction of stage 2 of the scheme which will provide another 16 berths at the comparatively modest cost of approximately £23 million. The ultimate justification for the scheme depends, indeed, on its proceeding in due course to stage 2 and it is not remarkable that stage 1 alone is not demonstrably viable.
- (ii) It seems probable that for less expenditure an equal addition to Britain's port capacity could be achieved at, say, Newport and Southampton. Development of Newport, however, would have a less dramatic impact and could not ultimately be on the same scale. As to Southampton, although it has considerable natural advantages as a port, it is not in some ways so well placed geographically as Portbury and the Council do not think that development there on quite the same scale is desirable in the near future. This is not to say that Southampton will not ultimately be developed as a major cargo port; in the Council's view the major attraction of Southampton lies in the opportunity it can provide for stage by stage development, the stages being each less ambitious than at Portbury, and the Council are in any case proposing a stage 1 development of Southampton in the interim national plan.

- (iii) If Portbury is carried out the outlook for Newport must inevitably be much less bright in the long term. This is inevitable but the point made earlier about the ultimate capacity for development of Newport is relevant.
 - (iv) There would be certain restrictions on the period of time each day during which the Portbury lock could be used for the very largest ships. These restrictions, however, would by no means be unacceptable.
15. The advantages of the Portbury scheme, as we see them, are:—
- (i) The scheme will produce a number of really deep-water berths, the general national need for which seems to the Council self-evident. Those allocated to bulk cargoes will cater for the largest foreseeable size of bulk carrier for commodities other than iron ore or petroleum. On the general cargo side, Bristol is a port which suffers from a serious imbalance of trade and the Council are convinced that the provision of new general cargo berths for export traffic will remedy this. It will, of course, be possible at Portbury to construct completely new facilities incorporating modern ideas. This scheme would be a dramatic new development and a clear manifestation of the Government's determination to bring the country's port facilities up to a standard equal to any in the world.
 - (ii) Given the steady growth of the national economy on which planning must be based there is reason to doubt whether by the late 1970's or early 1980's the ports of London and Liverpool will be able to contain the pressures upon them, even allowing for the substantial degree of development of those ports which is contemplated in the Council's interim national plan. Development of new facilities at Bristol would provide useful, and it might be essential, relief for pressure on London and Liverpool. In this connection the Council think it right to bear in mind, moreover, the part which planned location of port facilities can play in making possible a shift of emphasis away from south-east England.
 - (iii) With the completion of the Severn Bridge, the M.4 and the M.5, the road communications to and from Portbury will be first class. No other major port in the country could claim such an advantage.
 - (iv) The Port of Bristol Authority is, in the Council's view, one of proven operational efficiency and they have every confidence in the Authority's ability to make this ambitious scheme a success. Labour relations at Bristol are excellent and there is every hope that it will be possible at Portbury to achieve maximum mechanisation and efficiency.
 - (v) Planning of the scheme is well advanced.

Conclusions and Recommendation

16. There is very little experience to go on in assessing the merits of a major port investment scheme of this nature. In the Council's view the problem is one which calls more for an exercise of judgement than the application of an accounting formula.

17. Nevertheless it is right to make as judicious an appreciation as possible of traffic forecasts (on which revenue expectations necessarily depend) and it has been made clear earlier in this submission that the Council think it right to treat the consultants and P.B.A. forecasts as representing lower and upper limits of probability. The Council themselves consider that there is every ground for hope that in the event the results will prove to be closer to the P.B.A.'s than to the consultants' forecasts.

18. Accordingly the Council consider that the d.c.f. return will be near the 7·5 per cent based on the P.B.A. forecasts. While we should have liked to see a higher indicated rate of return emerging from the discounted cash flow exercise we feel bound to observe, first that the whole traffic forecasting exercise is, for a scheme like this, highly speculative, and second that we are not satisfied that *in the current situation* d.c.f. or other purely financial analyses should be the overriding criterion for reaching decisions on port projects for long term investment. The danger to the country's economy in the event of the inability, for whatever reason, of London and Liverpool to deal with the main growth of foreign trade in future years justifies, in the Council's view, a measure of insurance, and the consequent acceptance of a premium for that insurance in the shape of a forecast rate of return less than the 8 per cent apparently taken to be the desirable minimum for investment in the public sector. In this connection the Council have been impressed by the obviously strong desire of trading interests to see a major outlet for exports as an alternative to the ports of London and Liverpool. They also attach great importance to the Chamber of Shipping's view that Portbury's geographical position is such that it can be expected to attract export cargoes from many parts of the country and that there is accordingly a good prospect of Bristol's becoming a terminal port. Indeed the Chamber go so far as to say, in the light of current usage of the facilities of the Port of Bristol, that "it will be necessary to guard against the additional facilities planned becoming congested as a result of an excessive diversion of trades to the port". The feeling that there is a real need outside London and Liverpool for facilities such as Portbury can provide is, to our knowledge from contacts with many interests, widespread.

19. On a review of the whole problem, and of all the various factors discussed in this submission the Council have concluded that on balance the advantages of the Portbury scheme outweigh its disadvantages. They feel that special importance should be attached to the matters of communications and labour relations and also wish to lay emphasis on the fact that their conclusion has been reached on the assumption that the Government has a firm intention to further the industrial development of the South-West, and in particular of the immediate hinterland of Bristol, as a means of reducing the pressures of all kinds which have built up over the years, and which will almost inevitably continue to build up, in the South-East. It is, as the Ministry will be aware, the view of reputable planning bodies that the potential for growth in the South-West is great.

20. The Council recommend, therefore, that the Minister's approval for the Portbury scheme under section 9 of the Harbours Act should be given. In the Council's view it would be desirable for this approval to be given in

principle, with the condition attached that prior to the commencement of work on the construction of quay walls and sheds the final design should be subject to the Council's approval. This will enable us to deal at the right time with the points made in the section of this submission which deals with the technical aspects of the scheme.

21. As regards finance, the P.B.A. have so far indicated that they would be prepared to raise the necessary capital themselves. This is not, of course, an argument in itself for approving the scheme, which will involve the commitment of national resources however the capital is raised, but it may be relevant to the extent that financing of the scheme should not present any difficulty. If, in the event, the P.B.A. decide to apply for a Government loan under section 11 of the Harbours Act the Council are clear that it would follow from their recommendation that the scheme be approved under section 9 of the Harbours Act that they should also recommend it for a loan under section 11. It may well prove to be the case that arrangements for capitalisation of interest over the first five years would be advantageous to the P.B.A., and the Council would have no hesitation in recommending that such arrangements be made.

Annexure A*

Port of Bristol : present and forecast traffic

		1963-4 (Actual)	1980—without Portbury	1980—with Portbury	Thousands tons
		Consultants	P.B.A.	Consultants	P.B.A.
Foreign imports :					
Grain .. ..	..	987	1,251	1,260	1,251
Feeding-stuffs .. ..	..	484	778	778	778
Timber .. ..	..	158	280	280	450
Dry general cargo .. ..	..	977	1,195	1,195	2,000
Zinc ores and concentrates .. ..	..	510	1,017	1,437	1,767
Petroleum .. ..	..	1,104	100	300	1,600
Total .. ..	..	4,220	4,621	5,250	7,271
Foreign exports .. ..	..	186	215	215	465
Coastwise inwards :					
Coal .. ..	..	472	175	175	175
Sand and gravel .. ..	..	542	921	921	921
Other dry cargo .. ..	..	141	50	100	50
Petroleum .. ..	..	1,763	1,000	1,500	1,500
Total .. ..	..	2,918	2,146	2,696	2,146
Coastwise outwards :					
Dry cargo .. ..	..	265	366	366	366
Petroleum .. ..	..	577	50	50	50
Total .. ..	..	842	416	416	416
All traffic .. ..	..	8,166	7,398	8,577	10,298
					17,287

The P.B.A. considers that the existence of the Portbury facilities will attract traffic to the Port of Bristol which will in fact be handled at the Authority's present docks. The increased traffic forecast for Bristol with Portbury as compared with the "without Portbury" forecast may therefore appear greater than the Portbury facilities could handle. The P.B.A. considers that the alteration in the traffic pattern and improved utilisation of facilities which Portbury will make possible will ensure that adequate capacity is available.

* For revised statement see Annexure B to Part 2 (page 31).

Annexure B

Forecast Utilisation of Berths at Portbury based on P.B.A. Traffic Forecasts and average Rates of Dues and Other Charges.

		<i>Exports</i>	<i>Imports</i>			Thousand tons
	<i>Total</i>	<i>Petroleum</i>	<i>Bulk Cargoes</i> (Zinc Ores and Con- centrates)	<i>Dry General Cargo</i>	<i>Timber</i>	
Utilisation of Berths						
<i>Through Appropriated Berths</i>						
Berth						
1	Oil..	..	..	4,600		4,600
2	Container..	..	..	750	750	
3	Container..	..	..	750	750	
4	Other ..	..	..	300	300	
5	Other ..	..	..	300	300	
<i>Through Unappropriated Berths</i>						
6	Bulk ..	..	..	750		750
7	Container..	..	..	750		750
8	Other ..	..	..	255		55
9	Other ..	..	..	255		170
Total tonnages	..	..	8,710	2,385	4,600	750
					750	805
						170
Average Rates of Dues and Other Charges (in Shillings and Pence per ton)						
Goods Dues ..	..	..	s. d.	s. d.	s. d.	s. d.
Additional Dues†	..	..	2 10	4 0*	2 10	9 2
			6 7	1 0	—	—
			9 5	5 0	2 10	9 2
						2 10
Ship Dues (70 per cent of Goods Dues, excluding petroleum) ..	..	..	1 11	—	1 11	6 5
			11 4	5 0	4 9	15 7
						4 10
Cargo Handling Storage Rents ..	..	..	—	—	8 5	24 9
					—	3
Total ..	..	..	11 4	5 0	13 2	40 7
						24 1
Revenue from Dues and Other Charges		£1,350,000	1,150,000	493,000	1,634,000	205,000
						£4,832,000

* Combined Goods and Ship Dues.

† These additional dues are to be imposed where berths are appropriated and are in the nature of a rent.

Annexure C

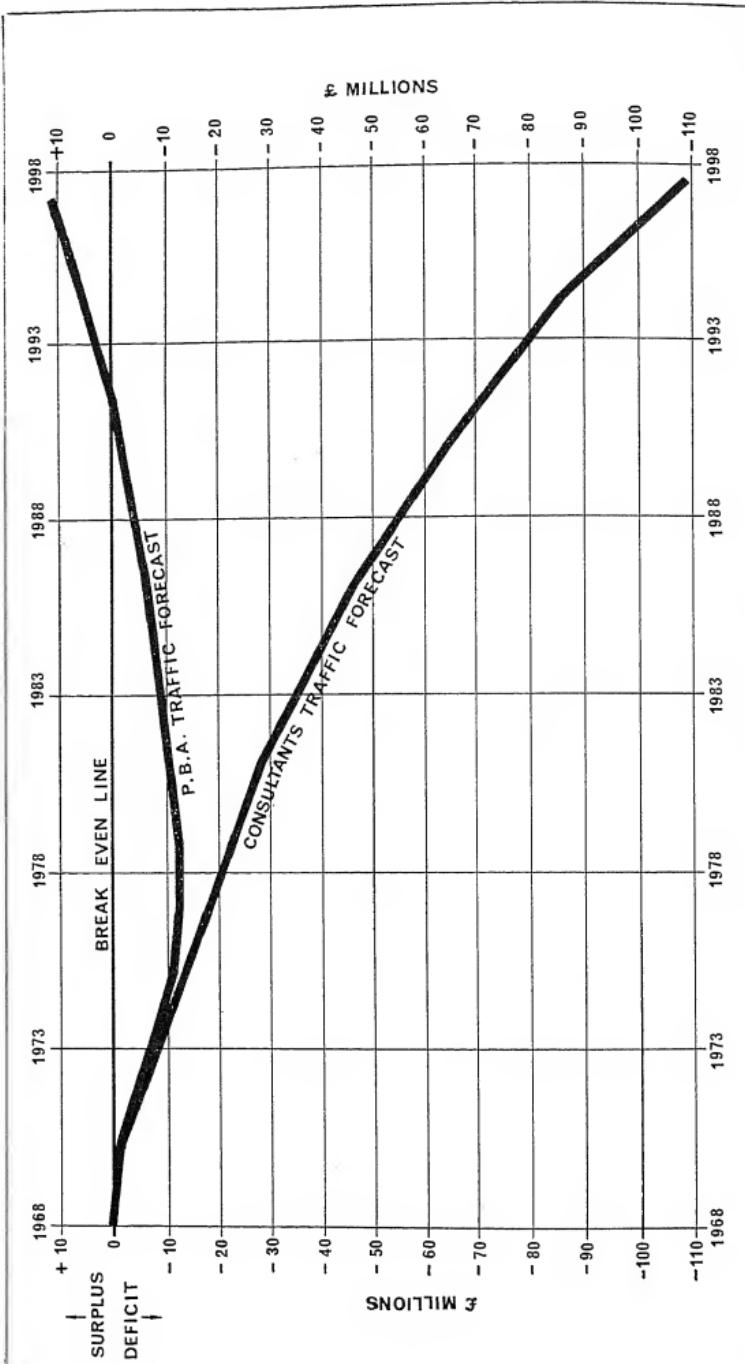
Forecast Revenue and Expenditure for Portbury, Year 1980 (Excluding Interest and Tax)

							£000s.
		<i>P.B.A. Traffic Forecasts</i>			<i>Consultants Traffic Forecasts</i>		
		<i>Revenue</i>	<i>Expendi- ture</i>	<i>Net</i>	<i>Revenue</i>	<i>Expendi- ture</i>	<i>Net</i>
Goods Dues ..	..	1,750		1,750	624		624
Additional Dues ..	..	1,017		1,017	157		157
		<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>
Ship Dues (70 per cent of Goods Dues, except petroleum) ..	..	2,767		2,767	781		781
		<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>
Total Goods and Ship Dues ..	..	3,348		3,348	1,007		1,007
Cargo Handling ..	..	1,452		1,008	444		258
Storage Rents ..	..	32			32	4	4
		<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>
		4,832	1,008	3,824	1,821	552	1,269
Craneage ..	..	214	136	78	71	45	26
Transport ..	..	409	301	108	136	100	36
Overtime ..	..	146	127	19	49	43	6
Water supplied to ships ..	..	41	28	13	13	9	4
Gas, Water and Electricity ..	..	70	60	10	28	24	4
Miscellaneous Rents ..	..	20		20	7		7
		<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>
Total Revenue and "Direct" Expenditure ..	..	5,732		1,660	4,072	2,125	773
		<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>
<i>Other Expenditure</i>							
Depreciation ..	..		570	(570)		570	(570)
Dredging ..	..		70	(70)		70	(70)
Maintenance and Minor Repairs ..	..		250	(250)		250	(250)
Major Repairs ..	..		70	(70)		70	(70)
Conservancy, Docking and Undocking Vessels ..	..		90	(90)		90	(90)
General Administration and Miscellaneous ..	..		276	(276)		276	(276)
		<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>
Total Revenue and Expenditure (excluding Interest) ..	..	5,732		2,986	2,746	2,125	2,099
		<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>
<i>Return on Capital Employed</i> ..	..				7.7 per cent		Nil

Note : Capital Employed is forecast at £35,500,000. This consists of the original investment of £27,000,000 to which has been added net outward revenue cash flows from 1968 to 1979, totalling £8,500,000.

Annexure D

Cumulative Surplus/Deficit After Interest



PART 2

**Letter dated 8th October 1965 in reply to a letter dated 6th August 1965
from the Ministry of Transport requesting certain further information.**

Financial Forecasts

We have obtained from the P.B.A. forecasts on a conventional accounting basis for the Port of Bristol as it exists at present showing the traffics and net results which the Authority expect to achieve in the years 1967 to 1992 (1967 being taken to be the year in which significant expenditure on Portbury might first be incurred). These forecast results are, in the P.B.A.'s view, capable of achievement whether or not Portbury is built and we have been at pains to ask the Authority to be particularly careful to exclude any possible double-counting of traffics. The results are set out in tabular form in Annexure A to this letter. Forecast results for Portbury have also been set out in the Annexure and the two sets of results have been aggregated to show the forecast future position of the Port of Bristol including Portbury.

The table shows that for the Port of Bristol with Portbury the cumulative deficit arising from Portbury can be fully covered by surpluses from the rest of the port by 1980-81 assuming depreciation for the rest of the port on a historic cost basis, or by 1985-86 if depreciation is charged on a replacement cost basis. The maximum aggregate deficit rises to £4·8 million (after depreciation on historic cost basis) in 1975-76 which slightly exceeds the estimated reserves for the Port of Bristol Authority of approximately £4 million at 31st March, 1966.

The forecast results after depreciation on replacement cost basis show, as would be expected, a larger aggregate deficit, but it must be borne in mind that when depreciation is charged on this basis Bristol, along with most other ports, will need to increase its charges generally. In view of this it may well be that the ultimate results would not be greatly different from the results shown in the column in Annexure A headed "after historic cost depreciation". Indeed, such an increase in the general level of charges could also improve the results for Portbury.

The forecasts of cash flow indicate a cumulative deficiency reaching a maximum of £0·6 million in 1973-74 but Investments and Bank Balances of approximately £2 million at 31st March, 1966 would be more than sufficient to provide the finance needed.

The results assume an interest rate of 6½ per cent applicable to both interest payable and receivable. (We have also prepared figures based on a rate of 6⅔ per cent, but as the aggregate results are not significantly different from those based on the 6½ per cent rate, we have not thought it necessary to quote them.) The results are, of course, unaffected by any incidence of tax, a circumstance partly arising from the provisions of section 66 of the Finance Act, 1965, which will operate to the P.B.A.'s advantage in later years.

Traffic forecasts

In preparing the financial forecasts discussed above the P.B.A. have worked basically on their own traffic forecasts for their port which were set out in Annexure A to our letter of the 28th May. I should point out, however, that

there has been some revision by the P.B.A. of the traffic forecasts for the port without Portbury. These revised forecasts are set out in Annexure B to this letter which now replaces Annexure A to our letter of the 28th May. The third column is the relevant one (there is a consequential adjustment in the fifth) and the main differences between the revised and the earlier forecasts are that it is now postulated that there will be somewhat greater quantities of foreign exports and of coastwise dry cargo inwards.

It remains true that the Council consider that the P.B.A.'s traffic forecasts may be somewhat optimistic. (Additionally both the Council and the P.B.A. feel strongly that little reliability can be attached to traffic forecasts for the very long term.) It must be accepted that there is some possibility that in the event the accumulated deficit for Portbury may persist after 1991-92 and that the d.c.f. returns on the scheme may be somewhat below those stated in paragraph 10 of our letter of the 28th May. Nevertheless the Council continue to believe that it is vital that the Portbury scheme proceeds at an early date. (I return to the general arguments for the scheme later in this letter.) As we have shown above the future revenues of the Port of Bristol as a whole should be capable of absorbing the Portbury deficit for as long as it may continue and, while we are not in principle in favour of cross-subsidisation between one part of a port and another, we are satisfied that the Port of Bristol will remain financially solvent assuming, as the Council do, that the P.B.A. substantially realises its traffic and financial forecasts for Portbury.

I now turn to two particular commodities:—

(a) *Petroleum*

As you know from the correspondence which the Department has had with the Ministry of Power it is not possible to be confident that the petroleum traffic in the P.B.A.'s Portbury forecast in respect of a power station (3 million tons per annum) will materialise. The C.E.G.B. have only just begun trial borings on the site and it appears that at least six months must elapse before the results of these investigations are known. Even if the site proves suitable it seems impossible at this juncture to be sure that a power station would be oil fired. Indeed the indications are to the contrary—see the C.E.G.B.'s latest Annual Report.

As regards a further 1½ million tons of petroleum in the P.B.A.'s Portbury forecast in respect of an oil refinery, the P.B.A. continue to be confident that there are good prospects of a small to medium refinery being built on or close to the Portbury site. Such a refinery is expected to be necessary to provide feedstocks in connection with the production of specialised products for the petro-chemical industries.

Even if the outcome of the power station and refinery prospects is negative the P.B.A. have assured us that they will be able to obtain an equivalent quantity of traffic. They have mentioned I.C.I.'s interest in moving bulk chemicals in liquid form to Severnside by pipeline from Portbury under the River Avon, and Williams Hudson Developments Ltd., a firm which has long specialised in the large scale handling of bulk cargoes at deep water berths, has expressed positive interest in operating one or more bulk berths at Portbury. There is additionally

the prospect which has emerged from your own contacts with an oil company that petroleum products may be shipped outwards from Portbury in large tankers.*

In the light of all this we have not insisted on an adjustment of the P.B.A.'s traffic and financial forecasts.

(b) *General Cargo*

The P.B.A. have now sent us, in strictest confidence, letters they have received from shipping lines and other potential users which have expressed interest in having berths at Portbury. The situation is as follows:—

Firm interest

Six shipping companies.

Strong interest

One shipping company.

One transport company.

Other expressions of marked interest

Four shipping companies.

Five industrial companies.

Two international associations.

[Names of the companies and associations were supplied to the Ministry of Transport.]

None of the letters, as you would expect, actually commits the companies concerned, and it does not appear that there have been discussions about the precise extent of terms, conditions and charges which these firms would have to accept in using Portbury but the Port of Bristol Authority assure us that a number of companies mentioned have indicated acceptance of the principles on which prospective rates have been assessed and also the broad basis on which calculations have been made.

South Wales Ports

I do not think there is a very great deal I can say about this aspect, since there is little point in repeating what was said in our letter of the 28th May and in the Council's Interim Plan.

You are well aware of the limitations of the South Wales ports. Swansea is relatively distant from the major industrial centres of Britain and must rely largely on traffics generated locally. Barry and Cardiff both have physical limitations: the cost of removing these would be great and the result would not even then be a thoroughly satisfactory modern port in either case. Newport is the best of the South Wales ports and accordingly we have proposed a measure of development there in the Interim Plan. But again the point is that to improve Newport radically would be highly expensive and the Council do not believe it can compare as a site with Portbury where all the advantages of starting from scratch on a large virgin

* Note : The name of the oil company and other particulars were supplied to the Ministry of Transport.

site with ideal communications can be obtained ; nor in the end can nearly so many berths be provided. The Council look forward of course to the completion of further stages of the Portbury scheme in future years. This concept, *and I cannot emphasise it too strongly*, underlies the Council's whole thinking about Portbury, which has been recommended to the Government as part of a long term national plan. In other words Stage I of the scheme must not be considered in isolation and without regard to the more distant future.

Cost of the Scheme

As you know, the Council's Technical Director and the Ministry's Harbour Engineer have recently visited Bristol for the purpose of reviewing the technical aspects of the scheme including cost. They have produced a joint report, a copy of which is in the Department's possession. It therefore seems needless to cover the ground in detail here and I propose to confine myself to setting out the broad conclusion we here have drawn from the report. This is that while on the one hand there are possibilities of savings on the scheme (e.g. in the constructional methods to be adopted for the lock and quay walls, and the design of road and rail works) and while it has now been established that the value of land to be taken into account for Stage I is only £4 million as opposed to the £1 million hitherto used in the calculations, on the other hand some items may well cost more than has been estimated and there is the general factor of rising prices in the last two years. Taking everything into account we think it is probably best to continue for the time being to use the figure of £27 million as the estimated total cost of Portbury Stage I.

Timing

We have looked at this problem in relation to the general question of priorities for the schemes covered by the Council's Interim Plan. While, as we have explained to you before, the Council regard all the schemes as of high priority and would be most reluctant to forego any of them, there can be little doubt that first priority ought to be given to schemes at London and Liverpool, for the reasons set out in the Plan itself. Portbury is a special case, difficult on the one hand to fit into the first degree of priority, because there is not the same certainty as there is with London and Liverpool that the facilities are essential to deal even with existing flows of traffic ; it is also true that the provision of 9 berths at Portbury will cost £27 million, 18 per cent of the total expenditure envisaged in the Interim Plan proposals. On the other hand, the Council attach the highest importance to Portbury being in operation by the early 1970's as a vital insurance factor in Britain's dock facilities, in that Portbury will make possible the relief of London and Liverpool by providing an extra channel through which the nation's exports can flow. It will be a relief of a specially desirable character since there is an area of ground which can be allocated to each berth, and the freedom of movement of road transport which this will permit, cannot fail to facilitate adoption of the most modern methods of cargo handling. If Portbury is to be available by the early 1970's a start on the works must be made as soon as possible.

We have also looked at the question in relation to your suggestion that we should provide an assessment of the likely situation of the major ports immediately before Portbury would be completed. With the best will in the world we do not think that an assessment on these lines could be produced which would be of any real validity or use. We frankly do not believe that we or anyone else can forecast the levels of the country's total port traffic 5 or more years from now, and the capacity of the other major ports in the country, with that degree of precision which would enable us to prove that the 9 berths of Portbury Stage I would be essential. The exercise would demand accuracy of forecasting for traffic and capacity combined within 1 per cent or 2 per cent which is really quite out of the question. The argument must, therefore, be considered in general terms.

I should add finally that the P.B.A. have now suggested that, given immediate approval and freedom from unforeseen snags, the first ships could be berthing at Portbury by the end of 1969. This is, we cannot help thinking, a somewhat sanguine expectation but we would go so far as to suggest that, with the same provisos, it might not be unreasonable to think in terms of the end of 1970.

Annexure A

Port of Bristol Authority

Forecast Cumulative Results, with Porthbury, assuming Interest at $6\frac{1}{4}$ per cent

		Cumulative Surplus/(Deficit) after Historic Cost Depreciation		Cumulative Surplus/(Deficit) after Replacement Cost Depreciation		Cumulative Cash Flow		
	P.B.A. without Portbury	P.B.A. with Portbury		P.B.A. without Portbury	P.B.A. with Portbury		P.B.A. without Portbury	P.B.A. with Portbury
1967	0.4	0.4	(0.2)	(0.2)	(0.2)	0.8	(0.2)	0.8
1968	0.9	0.7	(0.2)	(0.4)	(0.2)	1.9	(0.6)	1.7
1969	1.3	0.6	(0.7)	(0.5)	(0.7)	2.7	(1.2)	2.0
1970	1.9	0.2	(1.7)	(0.6)	(1.7)	3.5	(1.7)	1.8
1971	2.6	0.6	(3.2)	(0.5)	(3.2)	4.4	(3.2)	1.2
1972	3.3	0.0	(5.0)	(0.4)	(5.0)	5.3	(5.0)	0.3
1973	4.1	(3.1)	(7.2)	(0.2)	(7.2)	6.2	(6.6)	(0.4)
1974	5.0	(4.0)	(9.0)	0.0	(9.0)	7.3	(7.9)	(0.6)
1975	5.9	(10.5)	(4.6)	0.3	(10.5)	8.4	(8.8)	(0.4)
1976	6.9	(11.7)	(4.8)	0.7	(11.7)	9.6	(9.4)	0.2
1977	7.9	(12.4)	(4.5)	1.1	(12.4)	10.8	(9.5)	1.3
1978	9.0	(12.7)	(3.7)	1.6	(12.7)	12.2	(9.3)	2.9
1979	10.3	(12.7)	(2.4)	2.2	(12.7)	13.6	(8.7)	4.9
1980	11.5	(12.1)	(0.6)	2.8	(12.1)	15.1	(7.6)	7.5
1981	12.9	(11.6)	1.3	3.6	(11.6)	16.7	(6.4)	10.3
1982	14.4	(10.9)	3.5	4.4	(10.9)	18.4	(5.2)	13.2
1983	16.0	(10.2)	5.8	5.5	(10.2)	20.3	(3.9)	16.4
1984	17.7	(9.4)	8.3	6.6	(9.4)	22.3	(2.5)	19.8
1985	19.5	(8.5)	11.2	7.9	(8.5)	24.5	(1.1)	23.4
1986	21.7	(7.5)	14.2	9.3	(7.5)	26.8	(0.5)	27.3
1987	23.9	(6.4)	17.5	10.8	(6.4)	29.3	2.2	31.5
1988	26.2	(5.2)	21.0	12.6	(5.2)	32.0	3.9	35.9
1989	28.8	(3.9)	24.9	14.5	(3.9)	34.9	5.7	40.6
1990	31.5	(2.5)	29.0	16.6	(2.5)	37.9	7.8	45.7
1991	33.5	(1.0)	31.5	19.0	(1.0)	41.2	9.8	51.0
1992	34.5	0.7	38.3	21.5	0.7	44.7	12.1	56.8

Annexure B
Port of Bristol : present and forecast traffic

						Thousand tons
		1963-4	1980—without Portbury	1980—with Portbury		
		<i>(Actual)</i>	<i>Consultants</i> <i>(Revised)</i>	<i>P.B.A.</i> <i>(Revised)</i>	<i>Consultants</i> <i>(Revised)</i>	<i>P.B.A.</i> <i>(Revised)</i>
Foreign imports :						
Grain .. ..	..	987	1,251	1,312	1,251	1,312
Feeding-stuffs .. ..	..	484	778	778	778	778
Timber .. ..	..	158	280	280	280	450
Dry general cargo .. ..	..	977	1,195	1,293	1,595	2,098
Zinc ores and concentrates .. ..	..	510	1,017	1,437	1,767	2,187
Petroleum .. ..	..	1,104	100	300	1,600	4,900
Total .. ..	..	4,220	4,621	5,400	7,271	11,725
Foreign exports						
Coastwise inwards :						
Coal .. ..	..	472	175	175	175	175
Sand and gravel .. ..	..	542	921	921	921	921
Other dry cargo .. ..	..	141	50	304	50	304
Petroleum .. ..	..	1,763	1,000	1,500	1,000	1,500
Total .. ..	..	2,918	2,146	2,900	2,146	2,900
Coastwise outwards :						
Dry cargo .. ..	..	265	366	420	366	420
Petroleum .. ..	..	577	50	50	50	50
Total .. ..	..	842	416	470	416	470
All traffic .. ..	..	8,166	7,398	9,128	10,298	17,838

PART 3

Memorandum dated 30th June, 1966

1. The National Ports Council's recommendation of mid-1965, that the Portbury scheme should go forward, is generally known, since the Council's Interim Ports Plan published more than a year after Bristol first submitted their scheme included the Portbury development. This position, as to disclosure of a Council recommendation prior to Ministerial decision, has not arisen on any of the other submissions to the Ministry by the Council for port development schemes.

2. The Council's decision followed long discussion of the scheme and of the traffic and financial forecasts prepared by the Port of Bristol Authority and by their consultants, and was based on two primary considerations:—

- (I) The desirability of developing a third major deep sea liner terminal.
- (II) The general case for providing first class new capacity for such major ports as Bristol.

The Third Deep Sea Liner Terminal Concept

3. The information which has been produced for the Inter-Departmental Committee, following the recent production of the statistical results of Martech's work for the Port of London Authority on traffic flows, and the use of those results in gravity models by the Ministry of Transport's Economic Department confirm and underline the basic problems of the distribution of the deep sea general cargo traffics of this country and their inter-relation with the development of industry and services which were in the mind of the Council when they put forward their recommendation.

4. The Council stressed in their "Interim Plan" the overwhelming preponderance of Liverpool and London in these trades and that this corresponded with the broad requirements of the economic geography of the country. The Council remarked that "to try to shift . . . large quantities of general cargo . . . from London and Liverpool would be swimming against a strong tide" (paragraph 19 of Interim Plan), and that "to attempt to channel traffic to other ports by refusing to provide adequate and efficient facilities at London and Liverpool—would be damaging to the country's trade . . ." and concluded that "the right course is to provide a margin of capacity . . . at ports where growth is thought to be desirable while taking steps to improve and, within reason, expand the capacity of London and Liverpool" (paragraph 22). In recommending the Portbury scheme the Council were, in line with this general view, supporting both the modernisation of the important port of Bristol, and the case on national port planning grounds for avoiding an indefinite reliance on being able to match capacity at London and Liverpool with the progressively increasing volume of exports which if there were no alternative capacity it must be expected would pass through these ports. They believed this particularly important since, with the development of unit transport techniques, a larger rather than smaller proportion of general cargo traffic will probably move through

main terminals as compared to secondary ports. The Council also considered that it was their duty to propose measures which would mesh with the national policy of relieving the pressure on the economy of areas of dense population, notably Greater London.

5. The wording of the Interim Plan itself demonstrated that they fully recognised that such a major shift of traffic growth away from the London-Liverpool axis would be a major operation. But they came to the general conclusion that really first class facilities, correctly sited in relation to main communications axes, could achieve this result; not least in that by providing valuable transport infrastructure at a strategic point, such new dock facilities would themselves assist to generate a change in the total environment. Apart from the more distant history of such British ports as Liverpool the Council noted the importance of deliberate investment in good new port facilities in contributing to this "snowball" growth, for instance, at Rotterdam, Ghent, and Antwerp. This investment at both of the latter ports, it may be noted, includes very expensive lock systems.

6. After careful consideration of the alternatives, i.e. development of S. Wales ports or accelerated development at Southampton, the Council formed the view that Portbury was the scheme best suited to achieve this end. It would offer first class facilities, supported by a large land area, an established major port with an efficient management, and unsurpassed road and rail access to the main population and industrial areas of the country: although the initial cost of the scheme would be high because of the large tidal range of the Bristol Channel, so necessitating expensive locking arrangements, as in the Continental ports referred to above. The Council are, however, of the opinion that the significance of this initially high cost can be over-estimated in relation to total through transport costs. London and Liverpool are, for instance, blatantly more expensive ports than the Tees, but still attract the traffic.

Information derived from Martech Studies and the Gravity Model

7. These studies are discussed elsewhere in this report. They quantify the fact that the "wrench" from established patterns would have to be a very considerable one for Portbury (or for any other "third" terminal) to be successful. These studies must be evaluated with some care; and it is no derogation from the additions to knowledge these studies represent, to stress that they reflect the existing position and the organisation, through forwarding agents and others, of transport systems based on the traditional ports; against the background of no conscious deliberate effort to change this pattern by something reasonably large scale and really modern in the way of port facilities. They also indicate that in those cases where special attractions are available, e.g. the termination of most South African services at Southampton, this produces an exceptional traffic distribution relative to the general pattern which goes some way to confirm the theory that the pattern itself could be altered.

8. Nevertheless, it is more than ever clear that for any third major deep sea liner terminal port to be successful there would have to be a major diversion of total traffics, particularly traffics at present routed through London. The Council remain of the opinion that such a change in environment is desirable

from the planning point of view ; but recognise that the extent to which this alteration in the environment would be possible, even over the long term, is a matter of judgment. It is a fact, which would have to be accepted, that the success of Portbury as a counter-magnet to London and Liverpool depends to an important extent on the Government's determination to change the existing pattern of concentration of industry in existing areas.

Development of distribution of the foreign trade

9. The Council have taken account in this general assessment of two other factors. The first is that there is a strong likelihood that the main growth areas in the foreign trade of this country will be Western Europe and the North Atlantic region. In the former case there is no doubt that ports on the southern and eastern coasts are better placed geographically than Portbury to attract such trades. So far as the North Atlantic is concerned it seems unlikely that the growth of this traffic in any catchment area which can credibly be predicted for Portbury, or any other possible location for a third liner terminal, would be sufficiently great to support such a development. It must, therefore, be recognised that any third major deep sea liner terminal port must attract traffic from London and Liverpool, particularly the former.

Deep Sea Container Services

10. Since the publication of the Council's "Interim Plan", about which the Chamber of Shipping were consulted, the planning of British and foreign shipping companies in the container field has changed dramatically. It is still an open question whether the container has not been "over-sold", but it is now clear that several major American groups, a consortium of Continental shipowners, a Japanese group, and almost certainly one of the British shipowning consortia, have committed themselves to massive expenditure on the creation of "through" deep sea container services by 1968. So much money is being committed in this field internationally that there is no doubt that the shipping companies will endeavour by all means open to them to make these container services effective, i.e. seek to containerise all the traffic they can on the routes on which they operate. The same process is, of course, also taking place in the near sea trades.

11. The essence of the "container revolution" is that while highly specialised and exacting berths are required, supported by an expensive and complicated through communication chain, the capacity of such berths is vastly greater than that of "conventional" berths. Both because of this, and because of the necessity to concentrate traffic i.e. maximise utilisation of all components of the transport chain, such berths will probably be heavily used.

12. So far as British flag shipping is concerned there is no reasonable doubt, and this has been confirmed by the British Chamber of Shipping, that the initial bases will be at London and Liverpool. The Chamber does not exclude utilisation of further terminals in the long term ; but it must be accepted that in theory the whole of the present export general cargo traffic of London and Liverpool could be handled through not more than 10 container berths.

13. If the container revolution proceeds as fast and effectively as many leading shipowners here and abroad clearly believe, while new berths will be needed, the theoretical capacity for general cargo traffic of the two major

ports is capable of being developed to a point far higher than could be assumed even a year ago. In round terms it is perfectly possible, although far from certain, that the operational risk of congestion at London and Liverpool, as distinct from the planning and perhaps the industrial relations problems of reliance on two outlets for deep sea trade of this country, could be resolved, at least in the medium term, through intensive use of unit transport.

Modernisation of the Port of Bristol

14. The Council were also concerned about the future development of the Port of Bristol. The Port of Bristol handles some eight million tons of traffic a year and this seems bound to increase, notably those of the port's trades which are related to local consumption whether by industry or people. It consists of three groups of docks. The City Docks were developed in the early nineteenth century and consequently have a limited future utility. Portishead Dock is also limited, as is part of the Avonmouth system. Both unit transport, whether by containers or by other means, and modern bulk transport techniques all pose new and exacting requirements which will to a very large extent involve wholesale reconstruction. Counting the number of "berths" or even the linear quay footage available is no longer a satisfactory test of the likely capacity of a port.

15. The Council is generally of the opinion, (and this was basic to their Interim Plan) that in order to cater for the necessary modernisation of ports, it will be necessary to provide new capacity both to enable older capacity to be redeployed and also in due course to enable older capacity to be phased out of use altogether. This together with the long-term national planning concept of an alternative to the traditional general cargo ports, was an integral part of the Portbury proposal ; and indeed the Council have been assured by the Port of Bristol Authority that it is not possible to provide additional capacity within the Port of Bristol by any other means. Without further consultation with the Port of Bristol Authority in detail and considering the matter with some care, the Council are unable themselves positively to confirm that this is so ; but their own appreciation of the problem in the light of all the circumstances known to them, is that if Portbury did not proceed, the minimum improvement likely to be necessary at Bristol to cater for natural traffic growth, and modernisation, is likely to be a somewhat sub-standard redevelopment of part of the Avonmouth system, costing about £8 million. This figure would not include any costs which might well be necessary anywhere else in the port for the specific modernisation of specialised facilities ; and it is important to note that it would not enable any part of the Bristol port system to handle larger ships, a matter of some seriousness in the light of the high proportion of Bristol's traffic consisting of bulk materials. In the long term the result could be the slow strangulation of this vigorous, bustling and enterprising port.

Conclusion

16. After considering all these factors the Council are satisfied that there is a good case for Portbury as a desirable extension of Bristol's port capacity, although this in itself would be a sufficient justification for expenditure on the scale required by Portbury only for the very long term.

17. The Council are also satisfied that there is a case for a new major liner terminal, whose facilities, so far as can be seen, and inland communications will be able to meet the requirements of new transport techniques. They see this as primarily a long term issue of national port planning, correcting the existing and accelerating dependence of this country on a limited number of outlets for exports. They also consider that such a development would make a valuable contribution to the reshaping of the economic geography of this country.

18. It must be clear that in this the Council have been addressing themselves to the requirements of the deep sea trades. The similar but differing requirements of the short sea trades should be adequately dealt with by the substantial developments at Hull and Harwich Harbour which the Minister has approved on the Council's recommendation.

19. On balance the Council are satisfied that Portbury is the most attractive possibility for major development, outside the established ports of London and Liverpool. Of the alternatives which have been studied by the Steering Group, it is clear that all those arguments which weigh most heavily against Portbury weigh even more heavily against development in South Wales and, in the short and medium terms against Southampton; although there are separate grounds for substantial development at Southampton as indeed is proposed by the Council in their Interim Plan.

20. It would also have been theoretically possible to have studied in the same way other major ports in the country and among those, no doubt Hull with its large stake in the North Sea trades and its proximity to the populous northern industrial belt is the most attractive. It is, however, clear that geographically Hull is not as well placed to serve oceanic trades in competition with London as a port in the South-West; has similar communication problems to Southampton; and would be unlikely to be an effective counter-magnet to London.

21. The Council concede that the case for Portbury as a major liner terminal is, like the case for Portbury as a desirable extension of the Port of Bristol, a long term transport planning matter. They recognise that in the present difficult financial situation of the country it must be a major act of faith to commit financial resources to Portbury. They are nevertheless certain that such a decision should be made. They would point to the success of such continental ports as Rotterdam and Antwerp as evidence of the success of a generous investment policy, "Building for the future". In relation to this the Council feel most strongly that all the many interests concerned in port transport will base their decisions on their knowledge of what is certain to happen. Delay in the construction of new facilities, not only in the ports sector, has wider effects than the simple lapse of time involved. In that time decisions will have been taken committing people to long term policies which in the future will progressively inhibit to a greater and greater degree the scope for reshaping the environment. For instance, the success of the accelerated development at Tilbury which was proposed in the Interim Plan and which is now being implemented, is evidence of what can happen once really modern berths are known to be under construction.

22. The Council believe that the possibility of development at Portbury is an opportunity which should be taken, since they believe that the same opportunity will not recur. The British ports industry already has difficulty in competing effectively with the modern facilities in North West European ports, notably Rotterdam. Portbury would make a valuable contribution to correcting this situation.

ANNEX 3

The following tables give the inland origin of dry cargo exports other than coal shipped through all ports in Great Britain in 1964. The source in all cases is the P.I.A./Martech Study.

TABLE 1

All Regions

Port of shipment	Standard region of origin										All regions		
	London and South East	Southern	South Western	Wales	Midland	North Western	Scotland	Northern	E. and W. Ridings	North Midland	Eastern	Western	All regions
London ..	2,098·3	28·3	86·5	103·6	462·1	194·0	52·4	38·6	162·5	284·9	633·2	4,444·4	
Dover ..	1,58·6	1·3	9·8	5·3	63·9	1·9	—	—	2·9	2·2	289·9	289·9	
Shoreham ..	62·2	9·0	121·2	16·0	7·0	70·7	22·5	13·3	2·4	12·3	15·4	122·6	
Bristol ..	19·7	10·1	61·0	30·8	66·2	2·2	1·5	1·0	2·2	0·6	3·4	353·4	
Other Southern ..	83·8	39·9	1,546·1*	—	18·3	1·6	1·0	—	—	8·4	1·9	198·7	
Newport ..	—	2·5	6·3	509·0	17·0	0·8	1·0	3·1	—	10·7	9·2	1,709·2	
Cardiff ..	—	0·8	91·2	3·4	1·2	—	—	—	—	—	—	550·6	
Swansea ..	—	1·7	427·2	11·2	4·3	4·1	—	—	—	—	—	366·5	
Other Wales ..	69·7	12·4	0·7	494·1	71·5	42·0	0·9	0·3	1·0	—	—	448·3	
Liverpool ..	95·3	54·9	319·9†	118·7	575·0	2,235·2‡	126·8	207·0	499·3	223·4	700·8	700·8	
Manchester ..	—	4·2	0·4	6·7	103·4	316·2‡	9·9	—	152·8	38·0	37·9	4,493·5	
Other North West ..	—	—	—	1·2	32·7	59·4	3·8	29·1	15·4	—	—	3·3	663·4
Glasgow ..	—	0·7	—	—	—	—	0·8	0·9	711·8	8·5	3·1	11·5	142·2
Grangemouth ..	—	—	—	—	—	—	—	—	362·7	1·2	—	2·9	—
Leith ..	—	—	—	—	—	—	—	—	97·4	—	—	—	367·4
Other Scottish ..	—	—	—	—	—	—	—	—	66·8	—	—	—	98·1
Newcastle ..	—	0·9	—	—	2·8	—	5·3	7·8	6·3	193·1	13·4	—	66·9
Sunderland ..	—	—	—	—	39·6	—	4·2	14·6	—	212·6	5·7	—	235·7
Other North East ..	—	—	—	—	—	—	—	—	88·1	17·2	2·1	1·6	963·8
Hull ..	—	12·6	20·9	8·7	10·3	124·1	148·6	10·0	65·6	416·2	142·0	20·2	606·1
Goole ..	—	—	—	—	—	—	—	—	24·5	4·5	127·3	17·1	2·6
Immingham ..	—	—	—	—	—	33·0	8·1	1·2	15·3	56·5	18·0	—	211·3
Grimsey ..	—	—	—	—	—	—	8·4	2·6	—	37·9	112·2	—	99·5
Other Humber ..	—	—	—	—	—	—	8·9	—	0·5	17·2	38·6	7·1	63·5
King's Lynn ..	—	2·2	—	—	—	—	13·3	—	1·3	—	—	—	72·3
Yarmouth ..	—	5·1	—	—	—	—	0·6	—	—	—	24·0	20·2	61·6
Felixstowe ..	—	22·6	4·9	—	—	—	26·8	—	—	—	5·8	67·9	79·3
Ipswich ..	—	14·3	—	—	—	—	6·7	—	—	—	5·7	45·4	109·9
Harwich ..	—	88·9	4·8	1·0	5·6	—	26·6	—	1·0	—	2·0	22·3	50·3
Other E. Anglia ..	—	8·2	—	—	0·5	0·8	2·5	—	2·9	0·6	3·7	60·7	274·7
Total, all seaports ..	2,755·5	590·4	2,093·3	1,812·8	1,766·4	3,095·4	1,490·9	1,225·5	1,544·6	957·7	973·1	18,606·1	
All Airports ..	103·1	11·4	7·0	4·1	32·1	28·4	12·2	2·6	10·4	12·4	11·4	235·0	
Total ..	2,858·6	601·8	2,100·4	1,816·9	1,798·5	3,123·8	1,503·1	1,328·1	1,554·9	970·1	985·1	18,841·2	

* Mostly china clay. † See footnote to Table 4 (page 34).

TABLE 2
London and South-Eastern region

Port of shipment	County/conurbation of origin					Total	Thousand tons
	London	Kent	Surrey	Met.	Essex		
London	1,377.8	386.5	189.9	94.2	49.9	2,098.3	
Dover	74.8	23.6	30.1	11.3	18.7	158.6	
Shoreham	1.7	—	1.1	—	7.0	9.8	
Southampton	41.3	2.2	9.0	0.7	9.0	62.2	
Other Southern	33.2	11.4	13.0	0.2	26.1	83.8	
Bristol	17.9	1.5	—	0.2	—	19.7	
Other Wales	63.2	—	0.1	—	6.4	69.7	
Liverpool	80.7	5.1	3.5	4.9	1.1	95.3	
Hull	9.8	1.5	—	0.5	0.7	12.6	
Felixstowe	20.4	1.5	—	0.2	0.5	22.6	
Ipswich	11.5	—	—	0.5	2.2	14.3	
Harwich	68.8	—	0.1	17.5	2.5	88.9	
Other Seaports	15.8	—	4.0	—	—	19.8	
Airports	58.8	7.7	13.4	7.7	15.5	103.1	
Total	1,875.6	442.1	260.8	138.7	141.4	2,858.6	

TABLE 3
Southern region

Port of shipment	County/conurbation of origin				Other	Total	Thousand tons
	Southampton/ Portsmouth	Buckingham- shire	Berk- shire	Other			
London	45.9	68.9	62.2	104.3	281.3		
Dover	0.1	4.7	5.0	21.1	30.9		
Southampton	61.9	2.0	4.5	52.7	121.1		
Other Southern	11.2	0.4	1.3	27.0	39.9		
Bristol	—	0.7	1.6	7.9	10.1		
Other Wales	—	0.2	—	12.3	12.4		
Liverpool	6.5	1.9	8.6	38.0	54.9		
Hull	0.5	10.5	5.5	4.4	20.9		
Other seaports	—	5.7	—	13.3	19.0		
Airports	0.8	1.1	1.7	7.8	11.4		
Total	127.1	91.3	94.7	288.7	601.1		

TABLE 4
South Western region

Port of shipment	County/conurbation of origin			Total
	Bristol	Plymouth	Other	
London ..	15.2	2.6	68.6	86.5
Southampton ..	2.2	0.2	13.7	16.0
Other Southern ..	0.1	6.8	1,539.2	1,546.1
Bristol ..	19.9	—	41.1	61.0
Liverpool ..	9.3	0.8	309.8*	319.9
Other N.E. ..	—	—	39.6	39.6
Other seaports ..	6.0	0.1	18.1	24.1
Airports ..	2.3	—	4.8	7.0
Total ..	55.0	10.5	2,034.9	2,100.4

* This figure was used in the calculations described in Annex 4, but was subsequently found to be erroneous. The correct figure is 32.8, the balance of 277.0 being transferred to "North-Western Other" (Table 7, Column 3), where the figure 1,395.7 should be amended to 1,672.7, the totals in both tables and in table 1 being adjusted accordingly.

Correction of the error in Annex 4 would slightly decrease the traffic flow forecast for Bristol and make marginal adjustments necessary elsewhere. It would not affect the conclusions. Appropriate adjustment has been made in Table 5 of the main paper (page 7).

TABLE 5
Wales

Port of shipment	County/conurbation of origin			Total
	Swansea/ Port Talbot	Cardiff/ Newport	Other	
London ..	7.6	40.4	55.6	103.6
Bristol ..	0.2	29.0	1.6	30.8
Newport ..	13.8	276.2	219.0	509.0
Cardiff ..	81.8	—	—	81.8
Swansea ..	401.1	—	—	401.1
Other Wales ..	278.4	59.9	155.7	494.1
Liverpool ..	13.3	45.8	59.5	118.7
Hull ..	1.0	1.4	8.0	10.3
Other seaports ..	8.4	—	—	8.4
Airports ..	—	—	—	—
Total ..	701.1	557.5	558.3	1,816.9

TABLE 6
Midland region

Port of shipment	County/conurbation of origin				Total Thousand tons
	Birmingham	Coventry	Stoke-on-Trent	Other	
London	226.4	114.9	7.9	112.9	462.1
Dover	26.8	4.4	3.0	29.6	63.9
Southampton	22.1	31.5	—	17.0	70.7
Other Southern	7.1	1.1	—	10.1	18.3
Bristol	34.7	5.2	0.6	25.7	66.2
Newport	9.2	—	0.2	7.6	17.0
Swansea	2.1	—	—	9.1	11.2
Other Wales	53.0	0.9	1.5	16.2	71.5
Liverpool	339.2	65.2	53.0	117.6	575.0
Manchester	19.5	4.0	16.3	63.6	103.4
Other N.W.	3.9	—	—	28.8	32.7
Hull	80.9	15.3	5.6	22.4	124.1
Goole	12.3	9.2	2.9	8.6	33.0
King's Lynn	10.5	—	1.5	—	13.3
Felixstowe	20.5	—	0.2	—	26.8
Harwich	9.5	—	5.1	1.3	26.6
Other Seaports	25.0	—	5.6	—	50.5
Airports	17.8	4.6	—	1.7	32.1
Total	920.4	268.5	94.4	515.3	1,798.5

TABLE 7
North Western region

Port of shipment	County/conurbation of origin			Total Thousand tons
	Manchester	Liverpool	Other	
London	57.8	25.7	110.6	194.0
Southampton	8.6	0.8	13.0	22.5
Other Wales	7.8	2.8	31.4	42.0
Liverpool	330.8	508.7	1,395.7*	2,235.2
Manchester	157.0	5.4	153.9	316.4
Other N.W.	18.8	5.5	35.1	59.4
Hull	62.7	15.5	70.4	148.6
Goole	13.2	2.0	9.3	24.5
Other seaports	12.0	4.4	36.4	52.8
Airports	16.0	2.4	10.0	28.4
Total	684.7	573.2	1,865.9	3,123.8

See footnote to Table 4.

TABLE 8

Scotland

Thousand tons

Port of shipment	County/conurbation of origin					Total
	Glasgow	Edinburgh	Dundee	Aberdeen	Other	
London						
Southampton ..	35.1	3.3		0.4		59.4
Liverpool ..	5.9	1.7				13.3
Manchester ..	69.8	8.3	4.1	0.6	5.2	126.8
Glasgow ..	7.8			0.7	43.9	9.9
Grangemouth ..	473.9	23.5	17.4	10.2	186.8	711.8
Leith ..	216.3	2.1	8.5	0.4	135.5	362.7
Other Scottish ..	18.7	31.1	3.4	0.3	43.9	97.4
Hull ..	20.2	2.3	1.9	7.2	35.2	66.8
Other ports ..	7.5		0.4			10.0
Airports ..	11.3		3.1		18.4	32.8
Total ..	7.9	1.2	—	—	3.1	12.2
	874.3	75.6	35.7	20.9	496.5	1,503.1

TABLE 9

Northern region

Thousand tons

Port of shipment	County/conurbation of origin			Total
	Tees-side	Tyneside	Other	
London ..				
Liverpool ..	27.9	19.1	11.5	58.6
Manchester ..	94.4	59.3	53.4	207.0
Other N.W. ..	15.4	1.6	10.2	27.1
Newcastle ..	0.3	2.8	26.0	29.1
Sunderland ..	8.1	137.1	47.9	193.1
Other N.E. ..	0.7	23.0	1.9	25.6
Hull ..	762.1	19.1	100.5	881.7
Immingham ..	34.9	4.8	26.0	65.6
Other seaports ..	—	—	15.3	15.3
Airports ..	0.9	4.9	16.5	22.3
Total ..	944.6	272.4	311.0	1,528.1

TABLE 10
East and West Ridings

Thousand tons

Port of Shipment	County/conurbation of origin				Total
	Leeds/ Bradford	Sheffield	Hull	Other	
London ..	61.9	47.1	8.9	44.5	162.5
Southampton ..	7.8	3.8	—	0.6	12.3
Liverpool ..	150.7	182.9	20.5	145.2	499.3
Manchester ..	34.4	65.0	18.2	35.1	152.8
Other N.W. ..	2.3	11.5	—	1.6	15.4
Newcastle ..	1.3	1.6	5.5	5.0	13.4
Other N.E. ..	4.3	0.4	1.3	11.2	17.2
Hull ..	107.6	101.8	56.9	149.9	416.2
Goole ..	52.0	36.9	3.1	35.4	127.3
Immingham ..	0.7	17.0	—	38.8	56.5
Grimsby ..	8.7	8.8	—	20.4	37.9
Other Humber ..	3.8	8.5	—	4.8	17.2
Other seaports ..	7.0	2.6	0.3	6.8	16.6
Airports ..	4.7	2.1	0.4	3.3	10.4
Total ..	447.3	489.9	115.1	502.7	1,554.9

TABLE 11
North Midland region

Thousand tons

Port of shipment	County/conurbation of origin			Total
	Nottingham	Leicester	Other	
London ..	50.0	37.5	197.3	284.9
Dover ..	2.6	2.0	11.2	15.8
Southampton ..	0.7	3.4	11.3	15.4
Newport ..	—	—	10.7	10.7
Liverpool ..	73.2	23.2	127.0	223.4
Manchester ..	10.7	5.7	21.5	38.0
Glasgow ..	0.2	—	11.3	11.5
Hull ..	47.3	6.9	87.8	142.0
Goole ..	1.1	1.5	14.5	17.1
Immingham ..	2.8	—	15.2	18.0
Grimsby ..	0.5	0.8	10.9	12.2
Other Humber ..	4.0	2.9	31.7	38.6
King's Lynn ..	0.6	0.8	22.6	24.0
Harwich ..	3.6	13.3	43.2	60.0
Other seaports ..	6.8	—	39.3	46.1
Airports ..	2.9	2.6	7.0	12.4
Total ..	203.0	104.7	662.4	970.1

TABLE 12
Eastern region

Thousand tons

Port of Shipment	County/conurbation of origin					Total
	Non-metropolitan Essex	Norwich	Cambridge-shire	Other		
London ..	223.5	20.6	57.8	351.4	653.2	
Southampton ..	7.4	0.2		2.9		
Liverpool ..	5.0	1.3	7.4	24.3	10.5	
King's Lynn ..	—	4.4	4.7	11.1	37.9	
Felixstowe ..	16.2	5.7	1.9	21.6	45.4	
Ipswich ..	1.6	0.5	0.6	19.5	22.3	
Harwich ..	20.4	6.6	1.1	49.3	77.3	
Other ports ..	4.6	61.3		41.0	106.8	
All airports ..	1.1	2.2	2.9	5.3	11.4	
Total ..	279.8	98.2	80.8	526.2	985.1	

ANNEX 4

Mathematical Analyses of the Flows of Goods to and from Ports

1. Aims of the analyses

The availability of the P.L.A./Martech flow data allowed two hypotheses to be tested :—

- (i) that the share of export goods from a particular U.K. region sent through ports at a given distance away declines as the distance between region and ports increases ; and
- (ii) that, for a given exporting region larger ports attract a larger share of exports than smaller ports at any given distance.

Similar hypotheses were tested for imports. The basis of the first hypothesis is that exporters tend to minimise their inland transport costs, and of the second, that the larger a port, the more attractive is the service it can offer ; for example, more frequent sailings. The basic data did not allow account to be taken in this analysis of the final overseas destination of the goods. This is not a major source of error, because sea freight rates per mile are but a fraction of land haulage charges, and the differences in sea mileages brought about by choice of port are small. And the same can be said in relation to imports.

Two types of analysis were carried out, representing two independent approaches to the data, firstly a radial analysis and secondly a gravity model, and these are described in the following paragraphs.

2. The radial analysis

In this approach, a series of rings of fixed incremental radius was drawn round each port. It was decided to make the distance between each ring 25 miles. (Since in fact road distances were used, these rings are not exact circles.) Two variables are then examined for each port :—

- (i) the proportion of the exports handled in the port which originate in the zones centred in each ring round the port ;
- (ii) the proportion of the goods produced for export in the zones of each ring which are handled by that port.

Rings were also drawn round export-producing zones to test further factors, so that the third variable to be examined is :—

- (iii) the proportion of the goods exported by the zone passing out through the ports located in each distance ring away from it.

An analogous set of variables can be defined for imports.

The export data on which the analysis is based appears in the tables of Annex 3. The zones referred to in the above definitions are the 41 sub-regions of those tables. The ports used in the analysis are in most cases those listed in Annex 3. The identities of most of the ports in the list are in fact clear, with the exception of those groups of small ports designated by the prefix "Other". "Other North East" was identified as Tees-side, but the remaining ports with this prefix were omitted from the analysis. This was because of the impossibility of defining representative distances between these groups of small ports and the sub-regions. In all cases except one among these omissions, the tonnages involved are small. The exception was "Other

"Southern", but as the large export tonnages through this group consisted of china clay, it was convenient to omit this from the analysis in any case, as explained in paragraph 21 of the paper. Thus, the analysis was carried through for 25 ports. For each sub-region, where this was not specifically a large industrial town, a town was chosen to represent the centre of activity, and road distances were measured from this centre to each port. (As a comparatively small amount of the goods flowing to the ports is carried by rail, the road distances were taken as representative.)

The results are shown in Tables 1, 2 and 3. In Table 1, the results are given for all ports, and in Tables 2 and 3 for a selection of ports and sub-regions respectively. The entries in Tables 1 and 3 are expressed as cumulative percentages.

Both hypotheses which we set out to test were proved correct :—

- (i) The further away the port, the less proportionately of the region's exports it attracts. This supports the distance hypothesis ;
- (ii) The larger ports also attracted, proportionately, goods from further afield than smaller ports, which supports the second hypothesis.

Table 1 effectively defines the hinterlands of ports.

It is also clear from Table 3 that the major ports serve their own immediate conurbations almost entirely. A more detailed discussion of the results, together with tables which present the results in a summarised form, appear in paragraphs 9-14 of the main paper (pages 4 and 5).

3. The gravity model

The hypotheses outlined in paragraph 1, and their tentative justification in the radial analysis of paragraph 2, suggested that a gravity model would offer a good explanation of the flows, and thus create a tool which could be used for forecasting future flows. The model which was used can be written down as a set of equations, together with an explanatory list of the variables used. The variables for exports are as follows :—

T_{ij} = actual exports from zone i through port j .

T^*_{ij} = ditto, as produced in the model.

O_i = the total amount of exports originating in zone i .

X_j = the total amount of exports handled by the port j .

X^*_{ij} = ditto, as predicted in the model.

A_i = set of constants associated with the zones i .

B_j = set of constants associated with the ports j .

a, b = the parameters of the model.

f = a function of distance and the parameter b .

d_{ij} = distance between zone i and port j .

An analogous set of variables can be defined for imports. The equations of the model are :—

$$T^*_{ij} = A_i B_j O_i X_j^a f(d_{ij}, b) \quad (1)$$

$$O_i = \sum_j T^*_{ij} \quad (2)$$

$$X_j = \sum_i T^*_{ij} \quad (3)$$

Equation (1) gives the flows, and the constraint equations (2) and (3) can be satisfied if A_i and B_j satisfy

$$A_i = \frac{1}{\sum_k B_k X_k^a f(d_{ik}, b)} \quad (4)$$

$$B_j = \frac{X_j^{(1-a)}}{\sum_k A_k O_k f(d_{kj}, b)} \quad (5)$$

(Note that

$$\sum_i O_i = \sum_i \sum_j T_{ij} = \sum_i \sum_j T^*_{ij} \quad (6)$$

so that the total amounts produced in the model are constrained to equal the actual amounts.)

In the model tested, the distance function chosen was

$$f(d_{ij}, b) = \frac{1}{d_{ij}^b} \quad (7)$$

This is one of a number of standard functions. They normally give similar results, and as good fits were obtained with the function defined in (7), it was thought that a large amount of computer time should not be used testing other functions.

There are two ways of solving the equations of the model :—

In method 1, equations (4) and (5) are solved iteratively for A_i and B_j , and then both the constraint equations (2) and (3) are satisfied exactly. In this case, the parameter a must be taken as 1. The form of B_j in fact ensures that the equations reduce to this form. This can be seen by, putting $B_j = X_j^{(1-a)} B_1$. The model can be calibrated by finding the value of the parameter b which minimises $\sum_i \sum_j (T_{ij} - T^*_{ij})^2$, the sum of squares of differences between model flows and actual flows.

In method 2, all the B_j 's are taken as 1 and equation (5) is dropped. The A_i 's are then calculated from (4). A_i can then easily be interpreted as a term representing competition : it decreases for an i if there are several ports all "near" to i , and so shares the flows out of i between these ports. This method also allows several values of a to be tested, as an indication of the way in which size measures the attractiveness of a port. The parameter b measures the strength of the decline of a port's pull with increasing distance from regions. In this procedure, the constraint equation (2) is satisfied exactly, but not (3), and so is this now written as

$$X^*_j = \sum_i T^*_{ij} \quad (8)$$

and is used to give an estimate within the model of the total amount handled by each port. This method calibrates the model by finding an a and a b which minimise the quantities $\sum_j (X_j - X^*_j)^2$ and $\sum_i \sum_j (T_{ij} - T^*_{ij})^2$. The second of these quantities constitutes the best test, as the first quantity is trivially zero when $a = 1$, $b = 0$. There is no reason why the second sum should be a minimum at this point, and so $a = 1$, $b = 0$ does not constitute a good fit.

Method 2 was used to obtain the results described in this Annex. Method 1 has been used to calibrate the model, and similar parameters were obtained for the best fits, and so this will be discussed no further here. As further tests of goodness of fit, the correlation coefficients R_1 and R_2 between the sets X_j and X_{j*} , and T_{ij} and T_{ij*} , respectively were calculated. R_1^2 and R_2^2 are then measures of the amount of variance "explained" by the model, and can vary between 0 (for a bad fit) and 1 (for an exact fit). The values taken by these various statistical parameters for the range of values of a and b used to calibrate the model are given in Tables 4 and 5 for total exports and total imports respectively. These show that good values of a and b (with both R^2 's exceeding 0.9) are .

	Exports					Imports	
a	1.00	0.75
b	1.25	1.75

The average mileage travelled, derived from the actual data, and the model output, and the corresponding distributions of trip lengths, were also taken into account in determining the best a and b .

The actual totals and model totals for the amounts handled by the ports are shown in columns (2) and (3) for exports, and (5) and (6) for imports, of Table 6. Thus, it is clear that the gravity model gives a good "explanation" of existing flows.

The model was used to produce a set of forecasts. Forecasts were needed first of all for the amounts to be exported or imported in the various U.K. regions (the variables O_i) so that forecasts for ports could be obtained from the model, using the values of the parameters which have been obtained from the calibration phase. The only information available for the regions consisted of the forecasts for the economy as a whole used by the N.P.C. in their Interim Plan, and so these had to be applied to each region uniformly. It can easily be seen that if a rate of growth for, say, exports is applied uniformly to all the variables O_i , then all the T_{ij}^* 's, and hence all the X_{j*} 's, will be multiplied by the same factor. So the forecasts can be obtained by taking the average rates of growth of exports and imports to 1980, which were obtained as 84 per cent and 56 per cent respectively in paragraph 17 of the main text, and applying these to the 1964 model output for each port, the X_{j*} 's. Note that this does not mean that the percentage increases on present actual totals are the same as the national average. In fact, X_{j*}/X_j , for each port j , can now be usefully interpreted as the propensity to grow relative to the national average. The forecasts obtained in this way, which are presented in Table 6, thus allocate future flows exactly according to present gravity model parameters. The conclusions for Portbury are drawn in the main paper.

TABLE 1

Hinterlands—expressed as a cumulative percentage of Exports
Imports

Port	Total ('000 tons)	Miles :—	0-25	0-50	0-75	0-100	0-125	0-150	0-175	0-200	0-225	0-250	0-250+
1. King's Lynn	59·3	Exports	0	15	72	78	96	98	98	98	98	98	100
	380·0	Imports	0	0	74	80	88	98	98	98	98	98	100
2. Felixstowe	108·4	Exports	0	0	22	61	62	74	93	100	—	—	—
	193·5	Imports	0	0	5	64	64	91	91	97	97	97	100
3. Ipswich	49·6	Exports	0	0	4	69	69	85	88	99	99	99	100
	490·7	Imports	0	3	70	71	86	87	90	90	90	91	100
4. Harwich	272·1	Exports	0	0	8	61	61	63	70	76	96	98	100
	445·3	Imports	0	1	48	48	78	78	84	92	94	99	100
5. Yarmouth	78·7	Exports	0	67	67	85	86	98	98	100	—	—	—
	240·5	Imports	0	8	76	76	81	81	97	97	100	—	—
6. Leith	97·1	Exports	0	77	96	100	—	—	—	—	—	—	—
	956·6	Imports	0	86	94	100	—	—	—	—	—	—	—
7. Grangemouth	366·2	Exports	0	38	97	99	99	99	99	99	99	99	100
	762·3	Imports	0	91	97	97	97	97	97	98	98	98	100
8. Glasgow	736·9	Exports	0	64	93	93	95	95	97	98	98	98	100
	1,803·8	Imports	0	66	98	98	98	98	98	99	99	99	100
9. Newcastle	234·6	Exports	0	58	82	82	85	88	94	94	96	98	100
	721·5	Imports	0	63	97	97	98	98	100	—	—	—	—
10. Sunderland	25·6	Exports	0	90	100	—	—	—	—	—	—	—	—
	51·5	Imports	0	61	100	—	—	—	—	—	—	—	—
11. Tees	961·9	Exports	0	79	91	91	92	93	94	94	94	94	100
	1,215·4	Imports	0	52	89	89	90	91	92	99	99	100	—
12. Hull	970·3	Exports	0	6	21	43	61	79	91	94	96	98	100
	3,961·7	Imports	0	56	80	86	89	94	95	100	—	—	—
13. Birmingham	98·7	Exports	0	0	57	76	79	100	—	—	—	—	—
	1,160·4	Imports	0	0	64	93	96	99	100	—	—	—	—
14. Goole	210·5	Exports	0	0	61	67	82	94	98	97	97	98	100
	435·3	Imports	0	0	73	75	88	88	97	97	98	99	100
15. Grimsby	62·1	Exports	0	0	48	81	95	98	98	99	99	99	100
	372·4	Imports	0	0	84	86	90	90	—	—	—	—	—

TABLE 1—*continued*

<i>Port</i>		<i>Totals</i> (<i>000 tons</i>)	<i>Miles :— 0-25</i>	<i>0-50</i>	<i>0-75</i>	<i>0-100</i>	<i>0-125</i>	<i>0-150</i>	<i>0-175</i>	<i>0-200</i>	<i>0-225</i>	<i>0-250</i>	<i>0-280+</i>
16. Manchester	650·4 3,351·6	Exports Imports	..	48 75	67 83	77 88	95 98	97 100	98 —	99 —	100 —
17. Liverpool	4,481·2 7,712·6	Exports Imports	..	43 80	51 87	58 88	74 95	80 98	83 98	86 98	90 100
18. Shoreham	12·4 241·7	Exports Imports	..	56 72	65 72	79 87	85 91	85 91	85 94	100 97	92 97
19. Dover	286·2 447·7	Exports Imports	..	0 0	8 40	40 55	55 62	60 92	71 93	71 94	97 97
20. Southampton	362·7 904·8	Exports Imports	..	32 64	36 64	39 75	54 88	71 91	86 94	87 94	97 97
21. Bristol	196·3 3,184·2	Exports Imports	..	10 68	10 68	10 68	84 96	93 99	96 100	96 98	99 99
22. Newport	549·9 440·0	Exports Imports	..	50 27	50 27	53 79	95 79	97 79	98 100	98 —	99 —
23. Cardiff	96·1 551·8	Exports Imports	..	77 58	85 59	85 83	96 90	98 93	98 100	— —	99 —
24. Swansea	447·8 572·5	Exports Imports	..	84 66	89 66	89 66	89 66	95 94	98 98	98 98	99 99
25. London	4,443·7 13,511·3	Exports Imports	..	33 71	62 79	71 93	82 95	85 98	89 100	96 98	99 99

TABLE 2

Proportion taken of total { exports produced
Imports distributed } in ring

Examples	Port	Miles	0-25	25-50	50-75	75-100	100-125	125-150	150-175	175-200	200-225	225-250	250-+
25. London	Exports : percentage of total ..	79	49	43	29	26	13	7	15	3	5	
		Total ('000 tons)	1,863	1,640	525	354	1,760	435	1,490	4,320	486	1,220	1,790
		Imports : percentage of total ..	94	48	57	14	7	27	3	1	2	—	—
		Total ('000 tons)	10,150	2,340	3,280	59	3,880	1,430	—	—	—	—	—
17. Liverpool	Exports : percentage of total ..	81	53	39	31	22	11	13	5	26	5	
		Total ('000 tons)	2,340	728	857	2,370	1,240	1,040	893	3,780	2,020	1,380	1,750
		Imports : percentage of total ..	83	221	15	10	14	0	1	0	1	1	
		Total ('000 tons)	.. ..	7,420	2,490	465	5,270	1,950	2,940	—	—	—	—
12. Hull	Exports : percentage of total ..	50	30	25	8	6	7	3	4	1	0	
		Total ('000 tons)	114	500	835	2,140	2,930	1,600	960	487	2,000	1,800	2,400
		Imports : percentage of total ..	96	38	52	3	4	1	7	—	—	—	—
		Total ('000 tons)	.. ..	2,300	2,500	464	4,030	4,200	5,600	2,600	—	—	—
20. Southampton	Exports : percentage of total ..	31	4	6	3	2	3	1	1	1	1	
		Total ('000 tons)	376	338	184	1,890	2,450	1,980	1,000	380	3,000	1,000	3,140
		Imports : percentage of total ..	71	—	4	1	1	1	1	—	—	—	—
		Total ('000 tons)	.. ..	815	100	2,560*	12,400†	3,160	3,120	—	—	—	—
21. Bristol	Exports : percentage of total ..	38	—	0	—	4	1	—	—	—	—	
		Total ('000 tons)	.. ..	520	—	—	3,880	2,240	1,390	—	—	—	—
		Imports : percentage of total ..	99	—	0	—	18	1	1	—	—	—	—
		Total ('000 tons)	.. ..	2,180	0	0	5,000	10,300†	4,700	—	—	—	—

* S.E. Other.

† London.

TABLE 3
Distribution of $\{ \text{exports} \}$ between ports at varying distances from $\{ \text{producing} \}$ regions—cumulative percentages
Examples

		metres: 0-25	0-50	0-75	0-100	0-125	0-150	0-175	0-200	0-225	0-250	250+
	(000's)											
1. N.W. Other	1,788	87	87	88	92	93	99	100	—
2. Manchester	2,473	83	83	84	90	91	95	98	100
3. Liverpool	637	25	77	79	89	89	98	98	100
4. London	4,992	75	95	92	92	95	95	100	—
5. S.E. Other	10,113	561	95	99	99	100	—	—	—
Birmingham	2,458	7	8	91	96	97	97	98	98
Midlands Other	589	0	0	2	46	77	90	94	98
E.W. Riding Other	1,451	442	0	0	49	49	84	90	100
Hull	2,493	0	38	57	87	89	89	98	100
Glasgow	1,327	114	50	52	69	73	91	91	100
Scotland Other	1,795	2,300	96	99	99	100	—	—	—
North Midland	1,026	612	0	0	4	14	84	84	94

TABLE 4
Results of calibration for total exports

$b \downarrow$	$a \rightarrow$	0	0.25	0.50	0.75	1.00	1.25	1.50
0	187	3.4,9	2.3,9	1.2,9	3.0,8	1.3,-10	2.3,8	7.3,8
		6.0,8	5.4,8	4.8,8	4.2,8	3.9,8	3.8,8	4.0,8
		0.0	.79	.93	.99	1.00	.99	.98
		.04	.17	.31	.37	.39	.39	.39
0.25	171	3.2,9	2.1,9	1.0,9	2.2,8	9.0,6	3.0,8	8.1,8
		5.5,8	4.7,8	3.8,8	3.0,8	2.6,8	2.6,8	2.7,8
		.33	.83	.94	.99	1.00	.99	.98
		.15	.41	.58	.63	.61	.60	.57
0.50	152	3.1,9	1.9,9	8.6,8	1.6,8	2.4,7	3.3,8	8.3,8
		4.8,8	3.7,8	2.6,8	1.8,8	1.5,8	1.5,8	1.7,8
		.39	.83	.94	.99	1.00	.99	.98
		.34	.65	.80	.83	.81	.77	.73
0.75	129	2.9,9	1.7,9	7.5,8	1.5,8	3.1,7	2.9,8	7.4,8
		4.0,8	2.8,8	1.6,8	9.4,7	6.9,7	7.7,7	1.0,8
		.41	.81	.94	.98	1.00	.99	.98
		.48	.74	.88	.92	.91	.88	.84
1.00	107	2.6,9	1.6,9	6.7,8	1.5,8	3.7,7	2.2,8	5.7,8
		3.3,8	2.0,8	1.0,8	5.1,7	3.5,7	4.2,7	6.1,7
		.44	.79	.92	.98	.99	.99	.99
		.53	.76	.89	.94	.95	.93	.91
1.25	88	2.4,9	1.4,9	6.2,8	1.7,8	5.0,7	1.6,8	4.1,8
		2.9,8	1.7,8	8.4,7	4.5,7	3.5,7	4.0,7	5.3,7
		.46	.78	.91	.97	.99	.99	.99
		.56	.76	.88	.93	.95	.95	.94
1.50	75	2.2,9	1.3,9	5.8,8	1.9,8	6.8,7	1.3,8	2.9,8
		2.6,8	1.5,8	8.5,7	5.6,7	5.0,7	5.4,7	6.2,7
		.49	.77	.90	.96	.98	.99	.99
		.58	.76	.87	.91	.94	.94	.94
1.75	65	2.0,9	1.2,9	5.6,8	2.2,8	8.7,7	1.1,8	2.2,8
		2.5,8	1.5,8	9.3,7	7.2,7	6.7,7	7.1,7	7.7,7
		.52	.77	.89	.95	.97	.99	.99
		.61	.77	.86	.90	.92	.93	.93
2.00	58	1.9,9	1.1,9	5.5,8	2.4,8	1.1,8	1.0,8	1.8,8
		2.4,8	1.5,8	1.0,8	8.6,7	8.3,7	8.6,7	9.1,7
		.54	.77	.88	.94	.97	.98	.99
		.63	.77	.85	.89	.91	.92	.93

Example of notation : $3 \cdot 4,9 = 3 \cdot 4 \times 10^9$.

The results in each group refer to the value of a and b in the corresponding row and column. The five numbers in each group may be written and defined as

- X1 = $\sum_j (X_j - X_j^*)^2$
- X2 = $\sum_i \sum_j (T_{ij} - T_{ij}^*)^2$
- X3 = average mileage travelled. (The actual average was 66 miles.)
- X4 = R_1^2
- X5 = R_2^2 } as defined in the Annex (page 48).

It was decided that the best fit was that given by $a = 1.00$, $b = 1.25$. This is the joint minimum of X2, which is the most effective test, together with a relatively small value of X1, and an average mileage close to the actual one. Both R²'s are high.

TABLE 5

Results of calibration for total imports

$b \downarrow$	$\alpha \rightarrow$	0	0.25	0.50	0.75	1.00	1.25	1.50
0	187	2.1,10 1.3,10	1.4,10 1.2,10	7.4,9 1.1,10	2.0,9 9.8,9	2.5,—9 8.7,9	1.9,9 7.9,9	7.1,9 7.5,9
		0.0	.82	.93	.98	1.00	.99	151
		0.04	.13	.25	.35	.41	.44	.97
								.46
0.25	170	2.0,10 1.2,10	1.3,10 1.1,10	6.1,9 9.0,9	1.3,9 7.3,9	9.3,7 6.0,9	2.5,9 5.2,9	7.6,9 4.8,9
		.47	.86	.94	.99	.99	.99	133
		.13	.34	.53	.63	.67	.68	.97
								.67
0.50	149	1.8,10 1.1,10	1.1,10 8.8,9	4.7,9 6.6,9	8.4,8 4.7,9	3.3,8 3.5,9	2.8,9 2.9,9	7.4,9 2.8,9
		.54	.85	.94	.98	.99	.99	113
		.33	.61	.78	.84	.85	.84	.97
								.82
0.75	124	1.6,10 9.0,9	9.2,9 6.5,9	3.5,9 4.2,9	5.7,8 2.6,9	5.4,8 1.7,8	2.8,9 1.5,9	6.4,9 1.5,9
		.57	.84	.94	.98	.99	.99	93
		.52	.77	.90	.93	.93	.92	.98
								.90
1.00	99	1.4,10 7.1,9	7.3,9 4.5,9	2.5,9 2.5,9	4.1,8 1.3,9	6.1,8 7.8,8	2.4,9 6.9,8	5.1,9 8.0,8
		.59	.85	.94	.98	.99	.99	75
		.62	.83	.94	.97	.97	.96	.98
								.94
1.25	78	1.1,10 5.6,9	5.7,9 3.1,9	1.8,9 1.4,9	3.0,8 6.1,8	6.0,8 3.8,8	1.9,9 3.9,8	3.9,9 5.0,8
		.63	.86	.96	.99	.99	.99	61
		.68	.86	.95	.98	.98	.97	.99
								.96
1.50	62	9.6,9 4.5,9	4.4,9 2.2,9	1.3,9 8.6,9	2.6,8 3.6,8	5.9,8 2.6,8	1.6,9 3.1,8	3.0,9 4.0,8
		.68	.89	.96	.99	.99	.99	50
		.72	.89	.96	.98	.98	.98	.99
								.97
1.75	46	3.4,9 1.6,9	9.7,8 6.5,8	2.9,8 3.1,8	6.0,8 2.6,8	1.4,9 3.1,8	2.4,9 3.9,8	
		.91	.97	.99	.99	.99	.99	43
		.90	.96	.98	.98	.98	.98	.99
								.97
2.00	40	2.8,9 1.3,9	8.7,8 6.3,8	3.5,8 3.6,8	6.2,8 3.0,8	1.2,9 3.5,8	2.0,9 4.1,8	
		.91	.97	.99	.99	.99	.99	38
		.91	.95	.97	.98	.98	.98	.99
								.98

The five parameters in each group correspond to those defined in table 4 for total exports. It was decided in this case that the best fit was that given by $\alpha = 0.75$, $b = 1.75$. This value of X_2 is close to the minimum, coupled with a value of X_1 which is much smaller than that associated with the actual minimum of X_2 . The average mileage in the model is then reasonably close to the actual average of 36. Once again, the R^2 's are high.

TABLE 6
Results of the gravity model analysis

All totals are given in thousands of tons. The national average increases used in obtaining the forecasts are 84 per cent and 56 per cent for exports and imports respectively. The actual figures in column (2) differ slightly from those in Annex 3 because of rounding.

Port	Exports				Imports		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
		Actual total 1964	Model total 1964	Forecast 1980	Actual total 1964	Model total 1964	Forecast 1980
1. King's Lynn	..	59.3	35.4	65.3	380.0	221.6	344.6
2. Felixstowe	..	108.4	47.6	87.8	193.5	97.8	152.1
3. Ipswich	..	49.6	25.6	47.2	490.7	248.6	386.6
4. Harwich	..	272.1	124.7	229.9	445.3	212.1	329.8
5. Yarmouth	..	78.7	34.7	64.0	240.5	92.2	143.4
6. Leith	..	97.1	88.6	163.4	956.6	1,253.6	1,949.3
7. Grangemouth	..	366.2	233.6	430.8	762.3	550.3	855.7
8. Glasgow	..	736.9	965.0	1,779.5	1,803.8	1,746.0	2,715.0
9. Newcastle	..	234.6	238.9	440.5	721.5	834.3	1,297.3
10. Sunderland	..	25.6	19.0	35.0	51.5	65.0	101.1
11. Tees	..	961.9	1,284.0	2,367.7	1,215.4	1,181.9	1,837.9
12. Hull	..	970.3	650.5	1,199.5	3,961.7	3,656.2	5,685.4
13. Immingham	..	98.7	54.5	100.5	1,160.4	420.9	654.5
14. Goole	..	210.5	209.7	386.7	435.3	980.8	1,525.1
15. Grimsby	..	62.1	34.1	62.9	372.4	177.2	275.5
16. Manchester	..	650.4	1,029.0	1,897.5	3,351.6	4,387.5	6,822.6
17. Liverpool	..	4,481.2	4,546.9	8,384.5	7,712.6	8,143.5	12,663.1
18. Shoreham	..	12.4	7.1	13.1	241.7	719.1	1,118.2
19. Dover	..	286.2	123.2	227.2	447.7	260.4	404.9
20. Southampton	..	362.7	286.7	528.7	904.8	984.0	1,530.1
21. Bristol	..	196.3	142.5	262.8	3,184.2	3,182.9	4,949.4
22. Newport	..	549.9	586.4	1,081.3	440.0	374.7	582.7
23. Cardiff	..	96.1	101.5	187.2	551.8	427.2	664.3
24. Swansea	..	447.8	462.3	852.5	572.5	482.9	750.9
25. London	..	4,443.7	4,527.2	8,348.2	13,511.3	13,408.2	20,849.8

ANNEX 5

Shares of U.K. Trade, current and projected to 1980—per cent of total value

Zone	Exports			Imports		
	1965	1980 (a)	1980 (b)	1965	1980 (a)	1980 (b)
1. Irish Republic	.. ..	3·72	3·12	3·17	2·96	3·29
2. European Economic Community (exc. Italy)	16·84	22·50	24·40	14·76	16·35	20·00
3. European Free Trade Area (exc. Portugal but inc. Finland)	13·25	13·67	15·20	12·86	15·98	14·62
4. Soviet Union and Eastern Europe (exc. Rumania and Other Countries)	2·08	3·03	2·85	3·53	4·71	5·00
5. North America	.. ..	14·82	17·52	19·12	19·65	23·35
6. Latin America	.. ..	3·36	1·47	2·09	4·91	2·25
7. Sterling Area (exc. Irish Republic)	31·11	20·61	15·80	28·49	20·68	16·62
8. Mediterranean :—Italy, Portugal, Spain, Greece, Turkey, Yugoslavia, Rumania, Other East Europe Countries	6·92	9·33	8·67	5·57	5·73	8·86
9. Rest of World	.. ..	7·89	8·74	8·67	7·27	7·66
						10·91

(a) Projected from 1950—1965 trend.

(b) Projected from 1955—1965 trend.

Source—Board of Trade Reports on Overseas Trade.